OLOGY DEPARTMENT

THE INSTITUTION OF PRODUCTION ENGINEERS

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Contents:

8th INTERNATIONAL MANAGEMENT CONGRESS
Report by W. C. PUCKEY, M.I.P.E., F.I.I.A.

"MY HISTORY AND PERSONAL EXPERIENCE OF THE LARGE INTERNAL COMBUSTION ENGINE"
By H. J. GIBBONS, M.I.P.E., C.I.Mech.E.

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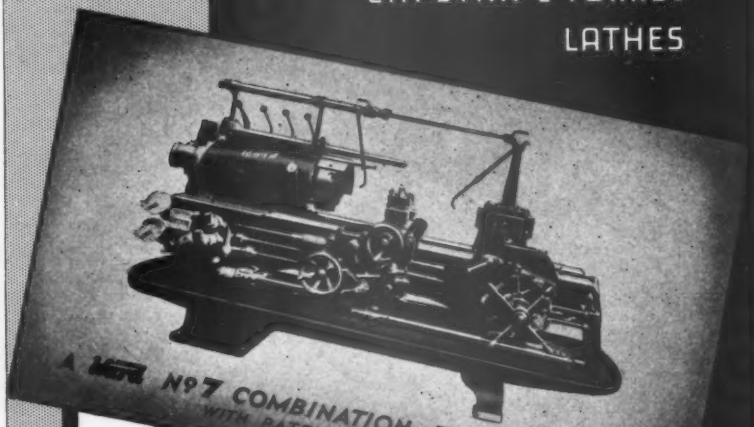

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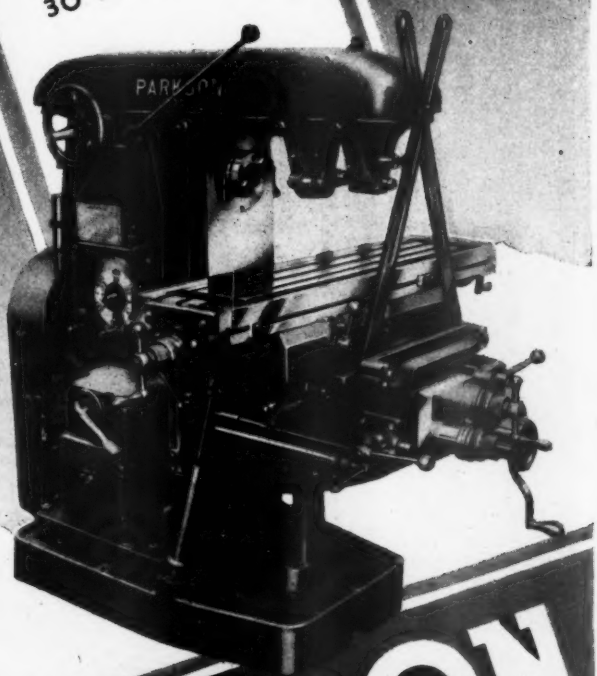

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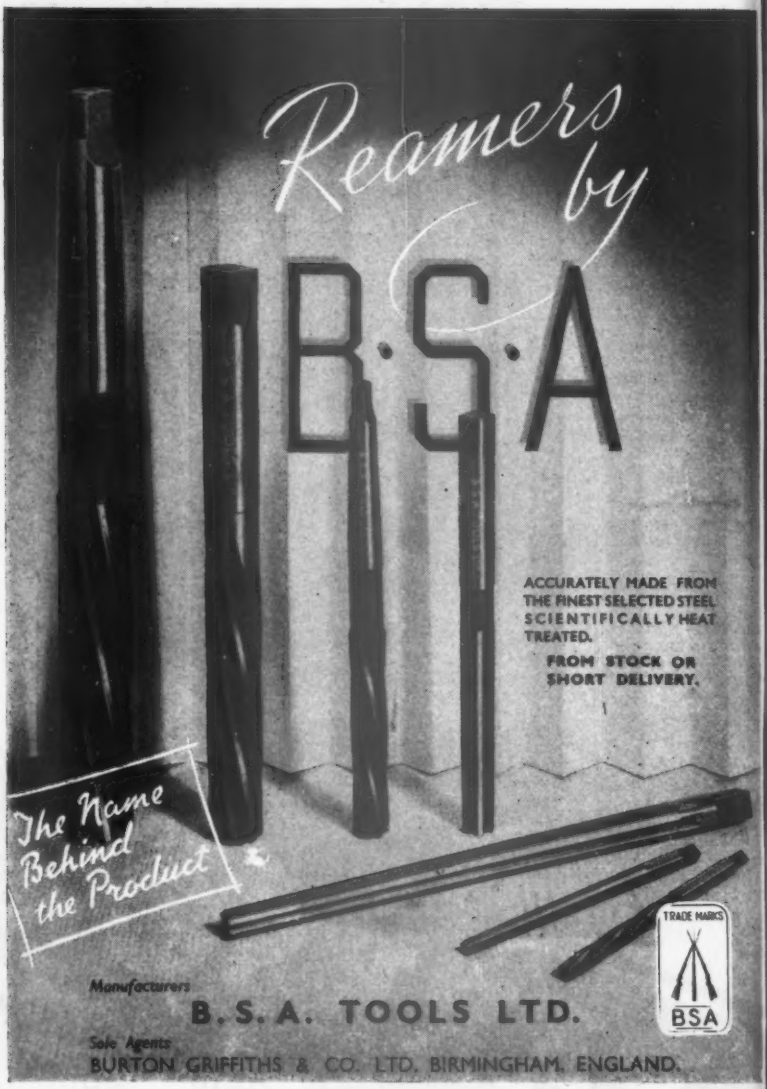
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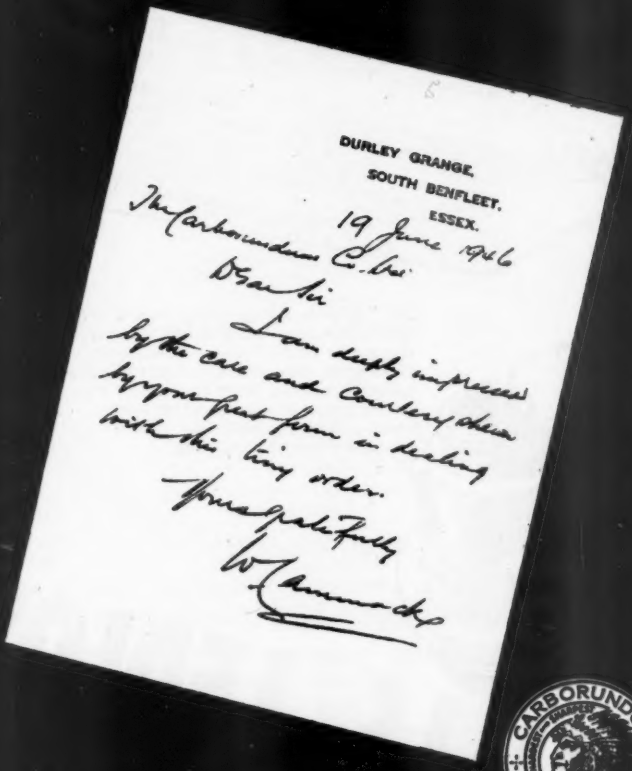
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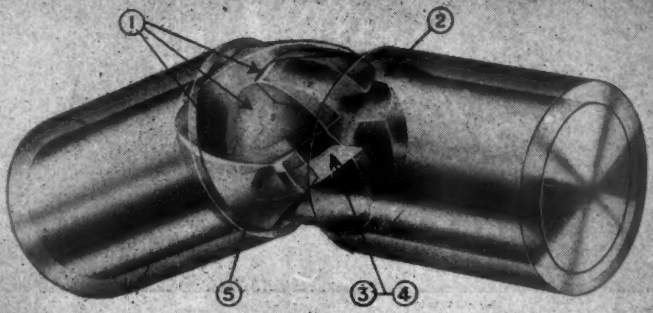

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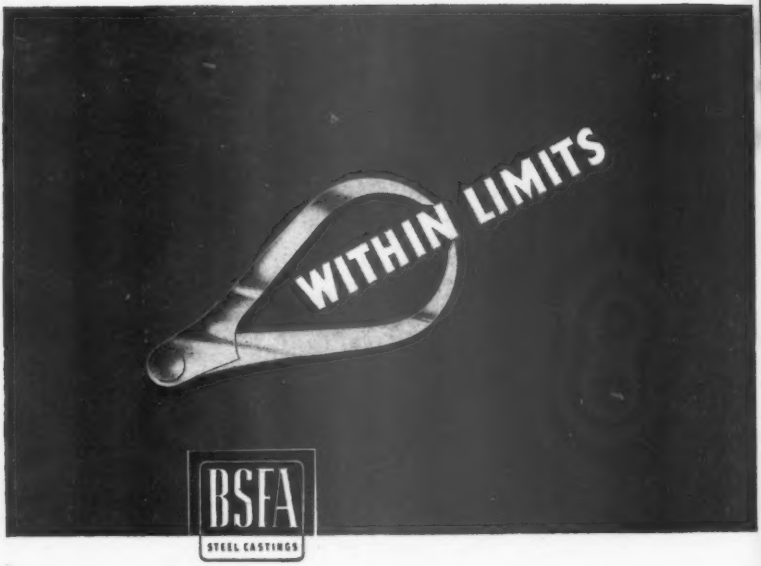

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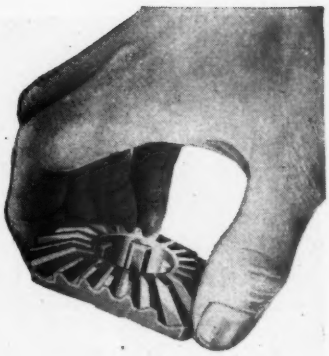

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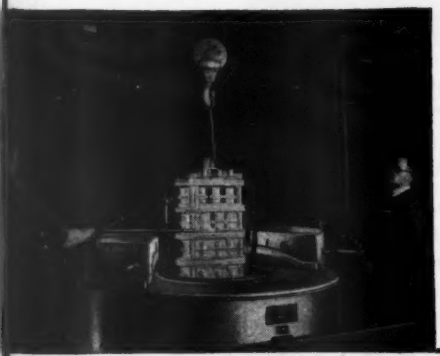

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INSTITUTION NOTES

November, 1947

The following meetings have been arranged to take place in November and December. Where full details are not given, these have not been received at the time of going to press.

November Meetings.

1st **Birmingham Section.** A Dance will be held at the Grand Hotel, Birmingham.

3rd **Yorkshire Section.** A lecture on " Engineering Uses of Cast Iron " will be given by Dr. H. T. Angus, M.Sc., at the Midland Hotel, Bradford, at 7-00 p.m.

4th **Coventry Graduate Section.** A lecture on " The Production of Aluminium Houses " will be given in Room A5, Coventry Technical College, Coventry, at 7-15 p.m.

5th **Preston Section.** A lecture on " Fabrication versus Castings " will be given by Mr. R. M. Watts, A.M.I.W., at the Harris Institute, Corporation Street, Preston, at 7-15 p.m.

5th **Nottingham Section.** A lecture on " Tooling and Methods Planning " will be given at the Victoria Station Hotel, Milton Street, Nottingham, at 7-00 p.m.

6th **Glasgow Section.** An Informal Discussion will be held at the Institution of Engineers and Shipbuilders in Scotland, Glasgow, at 8-00 p.m.

7th **Preston Section.** The Annual Dinner Dance originally arranged for this date will be held on 5th December.

7th **North Eastern Graduate Section.** A lecture on " The Manufacture of Gauges " will be given by Mr. N. Herbert, Grad.I.P.E.

10th **Halifax Section.** A lecture on " Full Employment in Industry " will be given by Mr. Austin Hopkinson at the White Swan Hotel, Halifax, at 7-00 p.m.

11th **Birmingham Graduate Section.** A lecture on " Production Metal Finishing " will be given by Mr. H. Silman at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 7-15 p.m.

November Meetings—*cont.*

12th **Wolverhampton Section.** A lecture on " Cutting Lubricants and Coolants " will be given by Mr. H. H. Beeny, M.Met., F.I.M., at the County Technical College, Wednesbury, at 7-00 p.m.

12th **Sheffield Section.** A lecture on " Foremen and Their Duties " will be given by Mr. E. Mensforth, M.I.P.E.

12th **Birmingham Graduate Section.** A visit to Fort Dunlop, Erdington, has been arranged.

12th **Southern Section.** A lecture on " Goblin and Ghost Jet Propulsion Engines " will be given by Mr. J. L. Edwards at the University College, Southampton, at 7-30 p.m.

12th **Manchester Graduate Section.** A lecture on " High Grade Cast Iron Castings " will be given by Mr. E. Longden, M.I.Mech.E., at the College of Technology, Sackville Street, Manchester, at 7-15 p.m.

13th **London Graduate Section.** A lecture on " Production Aspects of Spot and Seam Welding " will be given by Mr. C. A. Burton, M.I.W., at the Kingsway Hall, London, W.C.2.

14th **Coventry Section.** A lecture entitled " Some Notes on the Design and Use of Inspection Gauges " will be given by Mr. L. H. Leedham, M.I.P.E., A.M.I.Mech.E., in Room A5, Coventry Technical College, Coventry.

15th **Yorkshire Graduate Section.** A visit to Messrs. Scott Motors (Saltaire) Ltd., Shipley, has been arranged, starting at 2-30 p.m.

17th **Luton and District Section.** A lecture on " Interchangeability in Manufacture " will be given by Mr. F. Baker at the Town Hall, Luton, at 7-00 p.m.

17th **Derby Sub-Section.** A lecture on " Developments in Gear Cutting " will be given by Mr. F. J. Everest, M.Sc., A.M.I.Mech.E., A.M.I.E.E., at the Art School, Green Lane, Derby, at 6-45 p.m.

18th **Wolverhampton Graduate Section.** A lecture on " The Manufacture of Small Tools " has been arranged.

19th **Birmingham Section.** A lecture on " Electronics in Industry " will be given by Dr. W. Wilson, at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 7-00 p.m.

November Meetings—*cont.*

19th **Western Section.** A lecture on "Incentives to Direct and Indirect Engineering Workers" will be given by Mr. K. E. Taylor, A.M.I.P.E., at the Grand Hotel, Bristol, at 6-45 p.m.

19th **Liverpool Sub-Section.** A lecture on "Production Methods in the Motor-car Industry" will be given by Mr. L. P. Coombes, M.I.P.E., in the Arts Theatre, Liverpool University, at 7-15 p.m.

20th **Halifax Section.** The Annual Dinner Dance will be held at the George Hotel, Huddersfield, from 7-00 p.m. until midnight.

20th **Glasgow Section.** A lecture on "Production Engineering in Marine Shops" will be given by Mr. J. Green at the Institution of Engineers and Shipbuilders in Scotland, Glasgow, at 7-30 p.m.

20th **Leicester Section.** A lecture on "Conveyor Systems in Production Engineering" will be given by Mr. H. M. King at the College of Technology, The Newarkes, Leicester, at 7-00 p.m.

21st **Eastern Counties.** Mr. J. B. Webster, M.I.P.E., will give his Presidential Address in the Lecture Hall, Electric House, Ipswich, at 7-15 p.m.

25th **Halifax Graduate Section.** A lecture on "Press Tools" will be given at the Technical College, Huddersfield, at 7-00 p.m.

26th **Manchester Section.** A lecture on "Electronics in the Service of the Engineer" will be given by Mr. S. A. Ghalib.

26th **Western Section.** A lecture on "Personnel Management" will be given by Mr. L. E. Broome, A.M.I.P.E., at the Concert Hall, Westinghouse Brake and Signal Co., Ltd., Chippenham, at 7-45 p.m.

27th **London Section.** A lecture on "Precision Castings for General Engineering Purposes" will be given by Mr. F. Hudson, F.I.M., at the Royal Empire Society, Northumberland Avenue, London, W.C.2, at 7.00 p.m.

29th **Yorkshire Graduate Section.** A lecture on "Plastics in Engineering" will be given by Mr. J. Yarker at the Great Northern Hotel, Leeds, at 2-30 p.m.

December Meetings

1st **Yorkshire Section.** A lecture on " Modern Mining Machinery and Methods " will be given by Mr. W. Britton, M.I.M.E., at the Hotel Metropole, Leeds, at 7-00 p.m.

1st **Coventry Graduate Section.** A lecture on " The Development of the Radial Aircraft Engine " will be given by Mr. N. Rowbotham, C.B.E., M.I.P.E., (President of the Institution), at St. Mary's Great Hall, Coventry, at 7-15 p.m.

2nd **London Graduate Section.** A lecture on " Motion Study " will be given by Miss A. G. Shaw, M.A., M.I.P.E., at the Waldorf Hotel, Aldwych, London, W.C.2.

3rd **Preston Section.** A lecture on " Factory Management—New Tools for the New Job " will be given by Mr. A. J. Charnock, M.I.P.E., at Messrs. Clayton, Goodfellow & Co., Ltd., Blackburn, at 7-15 p.m.

3rd **Nottingham Section.** A lecture on " Work Routing and Paper Work " will be given at the Victoria Station Hotel, Nottingham, at 7-00 p.m.

5th **Birmingham Section.** A Joint Meeting with the Illuminating Engineering Society has been arranged, for the purpose of a Discussion on " Industrial Lighting and Decoration ", at the Imperial Hotel, Birmingham. Tea will be served at 6-00 p.m., and the Discussion will commence at 6-30 p.m.

5th **North-Eastern Graduate Section.** A Film Evening has been arranged, when the following films will be shown: (1) ' High-road to Production "; (2) " Age of Precision "; (3) " Researches in High Speed Carbide Milling."

5th **Preston Section.** The Annual Dinner Dance will be held at the Victoria and Station Hotel, Preston.

8th **Halifax Section.** A lecture on " Management " will be given by Lt.-Col. C. W. Mustill at Whiteley's Cafe, Westgate, Huddersfield, at 7-00 p.m.

9th **Birmingham Graduate Section.** A lecture on " Factory Acts Explained " will be given by Mr. T. A. Edwards at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 7-15 p.m.

10th **Wolverhampton Section.** A lecture on " Lighting for Efficient Production " will be given by Mr. W. Robinson, B.Sc., A.M.I.E.E., at the Wolverhampton and Staffordshire Technical College, Wolverhampton, at 7-00 p.m.

December Meetings—*cont.*

10th **Sheffield Section.** A lecture on " Engineering Applications of Polarised Light " will be given by Dr. J. Ward, B.Sc.

10th **Southern Section.** A lecture on " Light Alloy Extrusion Processes " will be given at University College, Southampton, at 7-30 p.m.

10th **Western Section.** A lecture on " Incentives to Direct and Indirect Engineering Workers " will be given by Mr. K. E. Taylor, A.M.I.P.E., at Wheatstone Hall, Brunswick Road, Gloucester, at 7-30 p.m.

11th **Leicester Section.** A lecture on " Modern Milling Practice " will be given by Mr. W. S. B. Kidd at the College of Technology, The Newarkes, Leicester, at 7-00 p.m.

11th **London Section.** A lecture entitled "The Gap Between the Production Engineer and Manager" will be given by Mr. W. C. Puckey, M.I.P.E., F.I.I.A., at the Royal Empire Society, Northumberland Avenue, London, W.C.2.

12th **Eastern Counties Section.** A lecture on " Industrial Radiography " will be given by Dr. R. H. Herz at the Brittania Works, Colchester, at 7-15 p.m.

12th **Coventry Section.** A lecture on "Modern Mining Machinery" will be given in Room A5, Coventry Technical College, Coventry.

13th **Western Section.** A Dinner and Dance will be held at the Grand Hotel, Bristol.

13th **Yorkshire Graduate Section.** A visit to Woolley Edge Colliery, Darton, near Barnsley, has been arranged, starting at 2-30 p.m.

17th **Liverpool Sub-Section.** A lecture on " Mechanical Handling" will be given by Mr. A. A. Simpson, A.M.I.P.E., A.I.Mech.E., A.I.E.E., in the Arts Theatre, Liverpool University, at 7-15 p.m.

18th **Glasgow Section.** A lecture on " Cutting Lubricants and Coolants " will be given by Mr. H. H. Beeny at the Institution of Engineers and Shipbuilders in Scotland, Glasgow, at 7-30 p.m.

19th **Halifax Graduate Section.** A lecture on " Precision Thread Rolling with Cylindrical Dies ", illustrated by a sound film, will be given by Mr. W. A. Hawkins at the Technical College, Halifax, at 7-00 p.m.

Inaugural Meeting of Liverpool Sub-Section

The Inaugural Meeting of Liverpool Section which took the form of a Dinner and Dance, was held at the Adelphi Hotel, Liverpool, on September 26th, 1947, and proved an outstanding success.

The principal speaker was Dr. George Gibson, C.H., Chairman of the North West Regional Industrial Board, whose address on the prevailing national and international situation made a deep impression on those present.

The guests included Mr. Norman Rowbotham, C.B.E., President of the Institution, and Major C. B. Thorne, M.C., Director and General Secretary ; The Lord Mayor of Liverpool, Alderman W. C. Gregson ; Professor R. G. Batson, M.M.G., A.K.C., M.Inst.C.E., M.I.Mech.E., Dean of the Faculty of Engineering at Liverpool University ; Mr. S. W. Brazendale, Regional Controller, Board of Trade ; and Mr. R. R. Butler, M.Sc., F.R.I.S., F.C.S., Principal of the City Technical College, Liverpool.

The Sub-Section already has 98 members, and in view of the enthusiasm roused by the Inaugural Meeting, the Section Committee is confident of a rapid increase in membership.

News of Members

Mr. W. Browning, M.I.P.E., has been appointed Director and General Manager of Messrs. Saunders-Roe, Ltd., Isle of Wight.

Mr. J. D. Smith, A.M.I.P.E., has been appointed Workshop Superintendent of the Schools of Technology, Art and Commerce, Oxford.

Mr. J. H. Howarth, A.M.I.P.E., has returned to New Zealand to take up his Directorship with Messrs. Liscarth, Ltd., Engineers and Manufacturers' Representatives.

Mr. G. A. Bayley, A.M.I.P.E., has taken up an appointment with The Plessey Co., Ltd., Ilford, as Production Development Engineer.

Mr. J. B. Clegg, A.M.I.P.E., is now Development Engineer for Cookson Sheet Metal Developments, Ltd., London.

Mr. E. G. Bones, A.M.I.P.E., is now Works Manager for Messrs. Birch & Co., Ltd., Hanley, Stoke-on-Trent.

Mr. K. R. Bannerjee, A.M.I.P.E., has been appointed Production Manager at the De Havilland Forge Ltd., Rogerstone, Newport, Mon.

Mr. J. H. Toothill, A.M.I.P.E., has been appointed a Director of Messrs. R. W. Toothill, Ltd., of Darlington, Co. Durham.

Mr. E. George, Int.A.M.I.P.E., has joined Messrs. Firth-Vickers Stainless Steels, Ltd., of Sheffield, as Assistant Mill Manager.

Mr. D. J. Carlisle-Kitz, Int.A.M.I.P.E., has been appointed through the Crown Agents to the Kenya and Uganda Railways and Harbours as a Designer.

Mr. G. R. Parry, Int.A.M.I.P.E., is now Works Manager of Pelapone Engines, Ltd., Wakefield.

Mr. William S. French, Int.A.M.I.P.E., has joined Messrs. Dowty Equipment Ltd., Cheltenham, as Methods Engineer.

Mr. W. P. Rickson, A.I.P.E., has taken up a position as Cost and Works Accountant with Messrs. Summit Manufacturing Co., Ltd., of Liverpool.

Mr. Frederick Howarth, Grad.I.P.E., is now a Designer Draughtsman in the Internal Combustion Engine Design Dept., of the English Electric Company, Ltd., Liverpool.

Mr. P. H. Armitstead, Grad.I.P.E., is taking up a position as Engineer-Assistant with the Hattikhira Tea Company, Assam, India.

Mr. H. Kellett, Grad.I.P.E., is now Assistant Works Manager with Messrs. Gilbert and Kellett, Ltd., Barrow-in Furness.

Mr. A. G. Bloomer, Grad.I.P.E., has been appointed Works Manager at Messrs. Whiteley Read, Engineers, Ltd., Basford, Nottingham.

Mr. E. J. Rice; Grad.I.P.E., is now Senior Design Draughtsman for Messrs. Stephen, Smith & Co., Ltd., of Millwall.

Obituary

We deeply regret to announce the death of Mr. J. C. Oliver, M.I.P.E., of Melbourne Section. Prior to his removal to South Australia, Mr. Oliver was a member of the Australian Sub-Council and the Sydney Section Committee, where his unceasing work for the Institution has been of inestimable value. His assistance and support will be greatly missed.

We also regret to announce the deaths of Mr. Charles Edwards, Int.A.M.I.P.E., of Western Section, and Mr. S. Geddes, M.I.P.E., of Glasgow Section.

Production Engineering Research Association of Great Britain

As a result of the formation by H.M. Government of the Mechanical Engineering Research Organisation in May, 1947, certain misunderstandings naturally arose as to the true relationship which would exist between the two bodies.

The Chairman of the Production Engineering Research Association of Great Britain communicated with the Department of Scientific and Industrial Research on 11th June, 1947, and the reply

to this communication, signed by Sir Edward Appleton, is published hereunder in order that members of this Institution may be conversant with the situation.

" From Department of Scientific & Industrial Research, Park House, 24, Rutland Gate, London, S.W.7.

To The Chairman, Production Engineering Research Association of Great Britain, Staveley Lodge, Melton Mowbray, Leics.

26th June, 1947.

" Dear Sir,

" I have to acknowledge the receipt of your letter of the 11th June, and to express regret that the announcement of the formation of the Mechanical Engineering Research Organisation of this Department should have led to any misunderstanding on the part of prospective members of your Association of the true relationship between the Organisation and your Association.

" The Mechanical Engineering Research Organisation of the Department is intended to carry out research work of a basic or general character for which provision is not already made effectively in other existing organisations. It will not and cannot take the place of those industrial or semi-industrial organisations, such as your Association, which provides more particularly for the technical needs of specific industries or branches of industries. Indeed, it would be impossible for any one organisation to cover adequately the whole field of research in the wide range of activities implied within the term mechanical engineering. The body of Research Associations, to which yours is a very welcome newcomer, performs a special service to industry and one which the Department would be extremely loath to see halted, even temporarily, by any misunderstanding amongst their subscribers of the respective activities of the Association and of the Department.

" While it does not appear practicable to attempt to arrange for press announcements such as you suggest, the Department would have no objection whatever to your making use of this letter in correspondence with prospective members, if you should come across any further instances of this type of misunderstanding.

Yours faithfully,

(Signed) E. V. Appleton."

Halifax Section Dinner Dance

The Annual Dinner Dance of the Halifax Section will be held at the George Hotel, Huddersfield, when the chief guests will be the Mayor and Mayoress of Huddersfield, Councillor O. Smith, J.P., and Mrs. Smith ; Mr. N. Rowbotham, C.B.E., President of the Institution, and Mrs. Rowbotham ; The Right Hon. Lord Sempill, A.F.C., and Lady Sempill ; and the Director and General Secretary, Major C. B. Thorne, M.C., and Mrs. Thorne.

Mr. E. W. PAULL

Mr. W. McMAHON

Visitors from Abroad

The Institution is pleased to welcome to this country two visitors from the Sydney Section, Australia, Mr. E. W. Paull, M.I.P.E., and Mr. W. McMahon, A.M.I.P.E.

Mr. Paull, who is Managing Director of Paull, Roberts & Parsons Pty. Ltd., formed a small engineering company, at the end of the 1914/1918 war, which has now grown to a considerable size and manufactures Dairy Farm Equipment and Machine Tools. He is an Australian delegate to the Metal Trades Committee of the International Labour Office, representing the Associated Metal Trades of Australia at Stockholm. His address while in this country is c/o Bank of New South Wales, Berkeley Square, London.

Mr. Paull has been a member of the Institution for a number of years and is also a Councillor of the Metal Trades Employers' Association of Sydney. During the war his company manufactured aircraft parts and machine tools, including plain milling machines.

Mr. McMahon has controlled the manufacturing activities of Lister Blackstone, of which firm he is Works Director, since its inception some years ago. He has come to the United Kingdom to visit the works of the parent company at Dursley. His address while here is c/o Lister Blackstone, Dursley.

Mr. McMahon has been a

member of the Institution for some time, and takes an active interest in the affairs of the Sydney Section.

Survey of Scientific and Technological Man-Power

The Ministry of Labour and National Service has been asked by the Advisory Council of Scientific Policy to compile a register of existing fully-qualified man-power in the fields of Science and Technology. The Institution of Production Engineers has been asked to co-operate in registering its members, and it would be appreciated, therefore, if those who receive the questionnaire now being circulated would send the desired reports to the Ministry as soon as possible.

The survey applies to all who took a degree in science or its equivalent (e.g. at least graduate membership of a recognised professional institution) in 1919 or later, and any members of the Institution who fall into this category and who do not, for any reason, receive the questionnaire, would greatly facilitate this work by applying for particulars to the Technical and Scientific Register, York House, Kingsway, W.C.2, or to any Regional Appointments Office of the Ministry.

Books Received

Rolling Bearings. By R. K. Allan, A.M.I.Mech.E., M.I.P.E. Sir Isaac Pitman & Sons, Ltd., 30/- net (2nd edition).

The second edition of this book is an excellent work and worthy of a prominent place in the reference library of all engineers who are interested in this very important subject.

Section I, which deals with the history of bearings, has added information on British Patent 139512, dated A.D. 1920, and Sections II and III cover the basic principles of bearing design with additional information on spin, etc. Materials and manufacture are clearly described in Section IV and will no doubt prove most interesting to designers and engineers. Formulae are well set out in Sections V, VI and VII, together with examples of their application, and Section VIII gives descriptions and diagrams of usual and unusual types of bearings.

Extremely useful information on the practical side is given in Sections IX to XV, including bearing selection, lubrication, fitting, maintenance, etc.

Finally, a very complete bibliography is set out in Section XVI, giving a list of the works which have been written on bearings from 1882 to 1945, together with a useful list of manufacturers both in this country and abroad.

J.W.H.S.

Transmission of Belting and Belt Drives. By H. Stuart Jude. Trade & Technical Press, Ltd. 30/- net.

The author treats his subject very thoroughly and in considerable detail. He builds up from the most elementary considerations, producing a book for the novice and the " old hand " alike.

Commencing with a review of the various factors influencing the selection of the most suitable belts for different circumstances, and proceeding to consider the factors involved in a number of simple examples, the author then gives his eight application rules, which he claims will enable a drive to be belted with the positive knowledge that it will show rock bottom operating cost per horse power hour.

The numerous operations in the manufacture of leather belting and the various types of leather belts, and their joints and splices, are considered, and chapters are also devoted to link-belting, fabric, rubber and vee-belts. Recommendations are given for the most suitable types of belts for various industrial applications. Pulleys, shafting and their alignment and safety measures also receive consideration.

The author is undoubtedly a belt enthusiast and some engineers may, we hope, be pardoned if they consider that he allows his enthusiasm too much play when, for instance, he states (on page 2) : " When the machine speed is required to be changed during operation, stepped cone pulleys satisfy the condition," and again, " By the use of fast and loose pulleys, a machine can be stopped or brought back into operation in a matter of seconds." Split seconds are, of course, often the prime consideration to-day.

Although the built-in electric motor has been steadily gaining ground in many fields, there is still plenty of room left for the application of belts. Mr. Jude's remarks on the correct way to mount a new leather belt show how easily many times the price of his book can be lost by lack of attention to this important point.

The publication is well printed, and the illustrations and many tables are simple and easy to follow.

A.A.J.F.

Issue of Journal to New Members

Owing to the fact that output has to be adjusted to meet requirements, and in order to avoid carrying heavy stocks, it has been decided that the Journal will only be issued to new Members from the date they join the Institution.

Important

In order that the Journal may be despatched on time, it is essential that copy should reach the Head Office of the Institution not later than 40 days prior to the date of issue, which is the first of each month.

8th INTERNATIONAL MANAGEMENT CONGRESS

Stockholm, 1947.

Report by Mr. W. C. PUCKEY, M.I.P.E., F.I.I.A.

(As reported in the September issue of the Journal, the Eighth International Management Congress, held at Stockholm on 3rd-8th July, 1947, was attended by a number of prominent members of the Institution. Mr. W. C. Puckey, M.I.P.E., F.I.I.A., who was among the delegates, was asked by the British Section of the International Council to act as Discussion Leader for the Production Session, and it is felt that his report on this Discussion will be of interest to many members.)

The Congress, which was attended by a large number of delegates from all over the world, had one session devoted to the subject of Production Administration. There were eight papers presented to this Section, and it was unfortunate that not one was put forward by a British contributor. This was very odd, bearing in mind the considerable attention paid to production in Great Britain over the last few years, and responsibility rests particularly with the Institution of Production Engineers in the future to see that production papers are adequately presented to forthcoming International Management Congresses.

In order to give members an idea of the scope covered by the Production Section, the following is a list of all those papers presented under this heading:—

" Progress in Production in the U.S.A.", by L. C. Morrow (U.S.A.)

" Study of Time and Movements ", by Lucien Allain (France).

" Studies of Working Methods in Swedish Forestry," by Gosta Luthman and Nils Lundgren (Sweden).

" Public and Collective Management Research ", by R. W. Starreveld (Holland).

" Significance of the Productivity of Labour ", by John A. Willard (U.S.A.).

" Progress in Industrial Work Simplification ", by A. H. Mogenson, H. B. Maynard and D. B. Porter (U.S.A.).

" Group Production—A Modified Production Line Layout for Small and Medium Job-Lot Machine Shops ", by C. B. Nathhorst (Sweden).

" The Principles of Incentives ", by Ralph Presgrave (Canada).

(Copies of these papers may be obtained from the Secretary, British Management Council, 15, George Street, London, E.C.4.)

The Institution of Production Engineers does not accept responsibility for any statements made or opinions expressed in any papers published in the Journal of the Institution.

Procedure for Discussion

All these papers were printed and circulated in advance to members, and a long session at the Congress was devoted first of all to an introduction by the Swedish rapporteur, who summarised briefly the main points of the eight papers. This summary is given at the end of this report. The session was then opened for members in general, and a number of questions were circulated in advance; those who wished to take part in the Production session were asked to notify the Chairman in advance of their desire to comment on one or more of the questions.

After the rapporteur had finished his summary, individual members were called by the Chairman to make their points, and as they were limited to five or six minutes, these points naturally had to be carefully prepared and put over in a concise manner. This had its advantages, but also the disadvantage that very little " meat " could be contributed, and my impression was that most of the points put forward were rather superficial. I can do no better than give an answer to each.

Question 1: What have we learned from the war and post-war era about industry's adaptability to changing conditions ?

The British point of view expressed here came under three headings:

(*a*) That much greater attention must be paid in future to lifting and shifting as distinct from the operation itself. It was felt that stores and work-in-progress values have increased disproportionately during the war, and that the control and movement of materials should be given greater attention in future.

(*b*) That much greater attention should be given to group operations and organisation.

(*c*) That our war-time experiences with Joint Consultation will probably continue into the peace, and will call for much closer relationships between all grades.

The French point of view was that the use of punched cards for production control at all levels was an important feature, and that the punched card system would extend its application considerably.

A representative from Czecho-Slovakia made the pertinent point that much better planning is required to avoid shut-downs owing to fuel restrictions. It was pointed out that in Czecho-Slovakia, during the severe winter of last year, their better planning made it possible for them to re-open after only three days' shut-down, compared with three weeks in Great Britain.

Question 2: Which are the most serious obstacles in different countries to increasing an efficient industrial production and how can they be overcome ?

A British point of view here was that the biggest obstacle standing in the way of increasing industrial production was the Trades Unions attitude towards working additional machines. One British member from the textile industry stated that he had been able to get full Trade Union co-operation in this matter, but it was obvious that this problem was one causing a good deal of trouble among many members.

Question 3*:* How can the essence of the principles for efficient manufacturing developed in mass production factories be applied in other industries, trades and crafts, and in countries with limited markets or impeded technological and economic development ?

A United States point here was that the use of sub-contractors was growing considerably. Apparently many small firms in the U.S. are setting up as specialists in a narrow range of work such as grinding, plating, etc., and because these firms are able to get such specialised work from a variety of main contractors, they are able to get a large volume of such work, thereby becoming highly efficient at their specialised jobs. The main contractors get the advantage of a shifting of their own load, and a very attractive price for the work they put out.

Another interesting trend in the U.S.A. is in connection with the printing of forms. A number of firms have apparently collaborated in designing standard forms and paperwork for such requirements as Medical, Personnel, Accounting, etc., and this enables bulk orders to be placed on a printer with a considerable reduction in price to each of the firms participating.

Another U.S. contribution dealt particularly with Mr. Nathhorst's paper. All production engineers are familiar with the classical alternative layouts—process layout or line layout. The point of view expressed here was that there is a trend towards the middle way, and production layouts in the future might tend more towards incorporating the advantages of both the process and line forms of layout. A further suggestion put forward by the U.S. member was that production layout work might start at an earlier stage. It was felt that such layouts might well have their origin in statistical studies carried out by the Sales or Engineering Department, and that these studies could tend to influence the actual production layout in a broader sense than the present practice of having layouts made almost on the shop floor level.

This particular delegate made the interesting point that the term " mass production " is an unfortunate one; it gives the impression to many people in countries outside the U.S.A. that such methods can only be applied in the U.S.A. He pointed out, as is very true, that efficient production methods are not necessarily tied up with the ability to produce on a large scale, and many people did not

adopt the right attitude towards efficient production methods because they felt that in their own works there would be no scope for the methods which had their origin in mass production units.

Question 4: What should be done to make work simplification and its true economic significance better understood throughout industry and to the public, so that suspicious and resistant attitudes may be overcome ?

A number of delegates were present who had given a great deal of study to the question of work simplification, and one had the impression that this aspect was receiving more than a fair share of attention, particularly bearing in mind the fact that all the applications were mainly to direct workers, leaving a very considerable number of other people outside the apparent scope of this study.

One U.S. delegate mentioned that synthetic times were being developed more and more; in other words, the time to be allowed for the job was being developed in the office from basic material rather than being built up from an actual study of the job in the shop. This system was challenged by a British member who felt that it would not be as fully acceptable to the work people as a time which they themselves had taken part in building up.

Another U.S. contribution emphasised that many new jobs were being introduced without adequate pre-study, and that much more time should be spent by the production engineering people on getting all conditions right.

Another interesting point of view put forward was that training programmes should emphasise more and more the economic problems of work prior to the introduction of technical problems. It was felt that new entrants into the firm, or those being retrained, would get a better idea of technical requirements if they had been given a previous course of introduction in the economic factors relating to the company.

The last, but by no means least, point brought up under this heading was the plea for better training for Methods Engineers, which really means a better training for Production Engineers generally. Many of those present endorsed this plea.

A French delegate described briefly some work which is being done in that country on the study of body movements in relation to light, noise, colour, etc. This was rather abstruse and appeared to be a general attempt on the part of biologists and psychologists to determine the reactions of the body and mind to the working environment.

To date this has apparently been mostly laboratory work, but they say they are now going to apply it in the building and other similar industries.

Question 5: Have physiological and psychological considerations been neglected in favour of statistical and technical aspects in the study and measurement of work ?

The British delegate described under this heading the work of the Production Efficiency Board of the Ministry of Aircraft Production during the war, and the further development of a similar department under the Board of Trade for encouraging production efficiency.

It was stressed that motion study had made considerable advances in this country during the war, and was to-day being used by a large number of firms.

The Swedish contribution here gave a brief description of the application of technical development among the workers in Sweden. The Swedish government appointed a committee about 10 years ago and reported, it is interesting to note, that rationalisation had in effect increased the standard of the workers and had not, as hitherto thought, lowered their working standards.

This delegate stressed the great importance attached to voluntary agreements in Sweden, and he felt that many delegates from other countries might have thought that the State had much greater control over such matters than it really had in that country.

The Dutch contribution here paid considerable acknowledgment to T.W.I. (Training With Industry) as a means of putting over better methods to all concerned.

A delegate from U.S.A. said that in his view one of the most important ways of putting over the economic significance of work was through the medium of training and re-training. He knew that the trainer had many more opportunities of creating the right attitude from the very beginning than the shop supervisors, and this fact alone made the organisation of first-class training well worth while. This view, incidentally, was shared by quite a number of people.

Winding up the contributions to this question were two further British points of view. The first one emphasised the great importance of reducing paperwork in the company, and of allocating authority right down to the line. This delegate emphasised that one of the biggest problems facing top management to-day was some means of giving it relief from the ever-growing pressure of business. He felt that right down to charge-hand level there should be a greater willingness to allocate authority, and consequently responsibility, for the things falling rightly within the individual's sphere, and he claimed that in the case of his own company this gave him far more time for the really necessary jobs of top management. He defined as the most important job of top manager that of creating enough time in order to walk round the departments and keep personal contacts alive.

The other British point of view gave results of a questionnaire issued to the workers in a large factory, asking them to state what they felt were the things needed most by them (the workers). The first six in order were as follows:

(1) A fair contract.
(2) Respect for the immediate supervisor.
(3) A pride in technical developments of the Company.
(4) Adequate explanation.
(5) Monetary incentives.
(6) Promotion opportunities.

This delegate made a point which was well appreciated by the majority of those present, that there had been too much emphasis recently on the necessity for organising production drives among the workers. What was really wanted was a production drive among management, and in this field were far greater opportunities of better management and greater production than in the field of exhortation to the workers.

Summing up very briefly, the following points stand out:

(1) The British delegation displayed considerable interest in production management.
(2) On this basis it is significant that no papers were submitted from Great Britain, a fact which should be remedied next time.
(3) The session devoted to production was, like many others, far too short to allow the interchange of ideas, and indeed the last two questions in the production session were not taken simply because of the lack of time. Most of the speakers towards the end of the session had not more than two or three minutes to put forward their opinions, and this was obviously inadequate.
(4) Bearing (3) in mind, there must obviously be considerable attention paid to the organisation of such Conferences in future, and it might well be that we should not attempt so much in such a short space of time.

I believe there should be more opportunities, particularly for small groups, to get together in order to thrash out more thoroughly one or two important questions in production, etc., because if the trend of the Swedish Conference is allowed to continue, managers will fall even more into the fault which is becoming so apparent to-day ; that is, the inability to get below the surface and to examine the problem in detail. In the opinion of this delegate, it is far more important to discuss two or three pertinent questions thoroughly than it is to skate over the top of a large number.

8th INTERNATIONAL MANAGEMENT CONGRESS

Stockholm, 1947.

Report to the Production Administration Session,

by HANS LINDEROTH.

The eight papers presented to the Production Administration Session deal with a great variety of subjects covering the whole field of production administration. Some are general, others take up more specific points for detailed discussion. It is obviously impossible in the short time available to the rapporteur to deal with all the interesting subjects presented. All I can do is sketch an outline of the composite picture presented by these reports and leave it to the delegates present to take up for further and more thorough deliberation such points as they find most interesting and important.

When it comes to studying industrial production quantitatively, we run into the problem of finding valid and relevant terms of measurement. Mr. Willard in his paper has made a study of proper and practical ways of measuring industrial output for comparative and statistical purposes. He has also made an analysis of the different factors influencing industrial productivity and gives in a simple but comprehensive way an analysis of some of the pertinent characteristics by which industrial progress may be described and measured.

Among other things the author finds that the general efficiency of management fell during the last war, and he declares one of the most pressing and difficult problems of to-day to be that of raising the quality of management. One of the graphs, by which the author illustrates his paper, shows that the productivity of labour which, all said and done, is one of the most significant measures of productive improvement, has gone down during this war as it did during the last one. (In both periods, incidentally, the advance in real wages per hour was at least maintained at its regular trend rate.) It would be interesting to know whether there are as yet any signs of a resumption of the trend in industrial productivity of the last decade, which has been rather a steady advance of a little over 3 per cent. a year.

The whole world has been surprised and impressed by the very high level of industrial production that the United States was able to reach and maintain during this war, and many interested observers have asked themselves how this stupendous result was achieved. In the paper presented by Mr. Morrow we find one part of the answer. He describes the improvement in production technique in the United

States since the last Congress, an improvement which covers all fields of industrial production and the cumulative result of which explains how the war production job was done.

All the same, there was much waste and inefficiency under the pressure of war. It is one of the problems of peace-time activity to eliminate such losses, while maintaining the advances achieved during the war. This certainly is not an easy problem, now that industry must supply a highly critical, price-conscious, civilian clientele. Some of the special developments mentioned in Mr. Morrow's report on the progress in production techniques during the last eight years include: improvements in plant layout and in material handling methods, better production planning, statistical quality control, improvements and extended use of work simplification methods, job evaluation, wider application of incentive plans, better training methods, etc. Many of the new techniques and systems are excellent and have been widely publicised and some of the examples cited of results achieved are startling indeed. None of them, however, offers an automatic solution to any of production management's problems, but they all depend for their successful application on wise administration.

It is important to keep in mind a basic difference between the United States and other countries: the guiding principle of economic life in the United States is the philosophy of abundance. This means that consumption is stimulated because it increases production, which in turn makes possible low prices through mass production economics. That this creed should be developed to such a degree in the United States has natural reasons. It is a country richly endowed with great and varied natural resources, it has a large market, practically unrestricted inside the country's borders, a favourable political system, highly developed science and technology and a strong spirit of enterprise. Very few other countries enjoy the combination of even a few of these conditions for their industrial development. From the analysis in Mr. Willard's paper it is evident that among the main reasons for the increase in productivity in the United States has been the increase in power supply, greater mechanisation of industry and improved technology. It also presupposes ample supply of raw materials, availability of skilled labour and efficient management, and a general atmosphere of co-operation and joint responsibility between management and labour, as well as freedom for industry from undue outside restrictions. All these are necessary requirements for increasing productivity anywhere and constitute the obvious but inescapable conditions for restoring industrial productivity in Europe as well as for developing hitherto not so highly industralised areas.

A more concrete example of how the differences between large and small countries may influence the organisation of a specific

industry is offered in the paper by Mr. Nathhorst. Line production consistently carried through usually presupposes quantity production of identical or very similar items. It is no accident that line production has been driven to high levels of perfection in countries with large markets such as the U.S.A., and in special industries with quantity production of relatively standardised articles, such as the automobile, electrical and household appliances industries. But countries with limited markets, and industries with a larger variety of products are handicapped and often frustrated by the difficulties in applying production principles, which have proved their value in mass production.

The paper by Mr. Nathhorst seems to indicate that real possibilities exist of utilising some fundamental practices of line production in industries with a wide range of different products. This has been done through the introduction of what the author calls group production, which, simply defined, might be said to be a means of making one production line do the work of several. The paper describes how group production solves a great many serious problems usually attached to job lot operation, such as those of planning, material handling and quality control. Incidentally it is indicated that group production stimulates more rapid technological improvements and makes for better industrial relations through the emphasis on team work. It would be gratifying to know that group production as here described would lend itself to wide application, and that further efforts were to be made to determine its possibilities, to establish principles for the composition of groups, and to solve other practical problems connected with it.

The closely related techniques of work simplification and the question of incentive wage plans have been treated in no less than four of the papers presented to this section.

Mr. Mogensen shows that an inescapable pre-requisite for real success with work simplification is that complete acceptance is won for the idea from the workers, the foremen and management up to the very top. The positive interest of all of these groups must be awakened and enlisted. This requires education and training, which is an art in itself. Mr. Mogensen states some principles for such education programmes, which have proved of great practical value not only for increasing production but for improving the general attitude of the workers, which, as the author notes, is at least as important a result.

Mr. Mogensen further points out that there have been signs of increased recognition of the value of work simplification in many fields outside industry proper, such as agriculture, office work, and in government and the military services. This is important as such activities employ a great share of the population in any country.

Messrs. Maynard and Porter describe the work now under way in the United States towards further refinements and standardisation in work simplification. This work comprises standard motion times, performance rating and uniform practices and nomenclature. Early and intimate international co-operation is desirable for more widespread application and accelerated progress in this field.

M. Allain in his report points out that motion study has been lagging in development and application compared to time study, this in spite of the fact that motion study when correctly applied usually gives better results than time study. It is apparent to all those who work in this field that the two are inseparable aids in the same endeavour, viz., to increase the yield of human effort and mechanical equipment. He also warns against non-scientific application of time study, and points out that any such system in order to be successful needs constant checking, consistency and firmness in policy and administration. M. Allain also states that as yet no scientific and objective method of performance rating has been developed which would make it possible to set really accurate standards for different types of work under varying conditions. So far, the best methods build on the experience and judgment of trained time study engineers. This is probably the greatest weakness from which time study suffers, in that it may render it suspect—even under otherwise favourable circumstances—in the eyes of the workers, or may offer a point of attack to its detractors.

M. Allain calls for more extensive basic physiological research, more intimate understanding and recognition of physiological laws in the formulation of motion economy principles, as well as closer collaboration between those concerned with research and theoretical work and those concerned with practical application.

Probably the most fascinating and, in the long run, promising approach to setting time standards is the use of standard element times. This relatively new development is still in its experimental stages and presents many new and difficult problems. There are, however, some, as far as is known, satisfactory applications of this technique, and it might be interesting, in the debate, to hear from such of the delegates as might have practical experience with a system of this type.

Although we must agree that there are attached to time and motion study many problems of fundamental importance, which are still not satisfactorily solved, it is clear and practically demonstrated beyond question that these techniques, provided they are used with discrimination and common sense, are among the very best tools of scientific management.

It is an interesting coincidence that one instance of such collaboration as M. Allain looks for is described in another paper in this

section. Mr. Luthman and Dr. Lundgren, one an engineer and the other a physiologist, for some years have been carrying on some very careful and painstaking research into all phases of common operations entailed in logging. This has great interest in Sweden, as forestry is the source of a good part of the national income.

It should be very interesting among other things to know from the authors if an attempt has been made to evaluate the results of the specific improvements that have been put into effect during the last few years.

Another interesting practice illustrated in this paper is that of checking the accuracy and validity of time standards by the use of statistical methods, in the same fashion as such have been applied to inspection in what has come to be known as statistical quality control.

Mr. Presgrave in his paper on incentive plans states very clearly the essential principles such plans must comprise. These principles are based on logic, psychology and experience, and are to-day widely accepted as basic elements in any well-conceived incentive plan for direct productive work, where measurement of the result as well as of the individual worker's time is no problem. In more complicated incentive applications it may be necessary to modify or depart from some of these principles, but they still constitute guides that should not be lost from sight. The author takes great care to warn against maladministration which may spoil the best incentive plan, and also against expecting an incentive plan to become a substitute for good management.

I have purposely left to the very last mention of the paper submitted by Mr. Starreveld. This is because his paper deals with rather a new approach to research into management problems and dissemination of the results of such research. The idea of collective research is an old one in all branches of science but has to our knowledge only recently and in a few instances been applied to the solution of management problems. It is no accident that Holland should be one of the first countries to embark on such a programme. The country has suffered from the war and is faced with the problem of rehabilitating its industries, while at the same time there is an acute shortage of scientifically schooled and experienced managerial personnel. The paper by Mr. Starreveld points to a great many of the advantages inherent in joint efforts. As a rule problems are handled on an industry-wide basis and it appears that the projects so far taken up are rather specific and lend themselves to quite fundamental research. It is clear that the form under which such research is carried out is sponsored by private enterprise but that, at the same time, it has the interest and backing of the Government.

The Swedish Institute for Industrial, Economic and Social Research has been concerned with the very same problems for quite

a few years. To begin with they were approached on rather a general economic level but during the last years, problems of a more practical nature have been taken up for treatment and research. In each case the work has been on a basis identified with a particular branch of industry. While we also have the same problem of insufficient competent personnel, interest at present seems to be directed towards the creation of research bodies by the various branch organisations in industry, as this seems a way of stretching available skill and multiplying its usefulness. Stress is put on achieving wide practical application of scientific management techniques already tested and well known, as well as more rapid acceptance of the results of more recent research. Good education and information service is needed in such an attempt to raise the general level of efficiency within each industry, within the frame of competitive and private enterprise.

As Mr. Starreveld points out, endeavours of this kind readily lend themselves to, and greatly benefit from, international co-operation and it is hoped that this activity will help to stimulate the exchange of knowledge and experience between different countries. No one can hope any longer that his country will be unaffected by political or economic events abroad. On the contrary, events have demonstrated the quick reaction everywhere of economic developments in any part of the world. Recognition of this common interest will, we hope, lead to ever-increasing international co-operation in the task of improving industrial efficiency and output.

Mr. H. J. GIBBONS, M.I.P.E., C.I.Mech.E.

Henry John Gibbons was born in 1876 at Thayatmyo, Burma (then known as British Burma), and at the age of four was brought by his parents to Maidstone, England, where he went to school.

In 1891, at the age of 15, he started work in London as an errand boy. While attending evening classes at the City Commercial College he was advised to take up shorthand. Four years later he took up employment in the office of an Investment Company, on the Accountancy side, handling share transfer work and registration for something like 3,500 shareholders. The Secretary of the Company subsequently made him his personal assistant because of his knowledge of shorthand, and when he later learned typing, he became one of the first young men in the City to possess these qualifications.

Mr. H. J. GIBBONS

Two years later, in 1897, he became personal assistant to a secretary who provided office accommodation and staff for nearly twenty companies and institutions, and left in 1898 to join the Premier Gas Engine Co., Ltd., of Sandiacre, Notts., which had just been formed to take over the business of Wells Brothers, manufacturers of gas engines. The appointment was that of accountant, but Mr. Gibbons also acted as assistant secretary, later becoming secretary, in 1905, when he was responsible for the commercial management of the company. In the same year he was elected a member of the Chartered Institute of Secretaries.

For many years he handled all commercial and contract work of his company, in addition to the finance and accountancy, and was appointed a director in 1918. Some twelve months later the company came under the control of Crossley Brothers, Ltd., and on Mr. Hamilton's retirement in 1930, Mr. Gibbons was made Managing Director of the Premier Gas Engine Co., which position he held until retirement in 1946. During this period he also joined the Board of the parent company, Crossley Brothers, Ltd.

In addition to becoming a Fellow of the Chartered Institute of Secretaries, Mr. Gibbons became President of the North-East Midlands branch of that body, and was also elected a Companion of the Institution of Mechanical Engineers by reason of the important work carried out in the development of the internal combustion engine. In 1938 he was made a Member of the Institution of Production Engineers and was installed President of the Nottingham Section by the Rt. Hon. Lord Sempill, A.F.C., M.I.P.E. During the last war he served on the Institution's Executive, Finance and Research Committees.

For many years he held the office of treasurer and was an *ex officio* member of the Committee of the Nottingham District Engineers' and Allied Employers' Association, and is still serving as a member of local committees dealing with Management, Labour and Education. He is also a member of the Engineering Advisory Committees of the Nottingham University College and the Nottingham and District Technical College.

In 1945 he was elected Honorary Treasurer of the National Institute for the Deaf in London, which post he still holds.

"MY HISTORY AND PERSONAL EXPERIENCE OF THE LARGE INTERNAL COMBUSTION ENGINE"

by H. J. GIBBONS, M.I.P.E., C.I.Mech.E.

(*Presented to the Institution of Production Engineers, Nottingham Section, April 3rd,* 1947)

It was suggested by the President and other members of your Committee at one of their meetings that it would be interesting to the members of the Institution if I gave my personal experience of the early development of the Internal Combustion Engine, particularly the gas engine, in this country.

It is a fact that the success of the gas engine in the later years of the nineteenth century and the early part of the present century has been responsible for the present-day trend of progress. Without that success, you would not to-day have had the petrol engine driving your motor cars, the heavy oil engine driving your 'buses and lorries, or the high octane fuel engine which is responsible for the power developed in aircraft.

I know that the late Mr. Lanchester, who was one of the pioneers of the internal combustion engine, stated in one of his lectures to the Institution of Mechanical Engineers that the success of the internal combustion engine was in some ways a curse and a tragedy to mankind. This was before the war broke out in 1939—he put down as a terror to humanity the airplane for bombing and the submarine for sinking ships. (I do not think he then envisaged the tank being used so much in warfare.)

Early History.

Perhaps before I give my experience of the internal combustion engine, I ought to give a few notes on its early history. Many of you have studied it, but probably the younger generation has not yet done so.

From a paper which was read before another Institution by a namesake of mine, in 1937, it was stated that the earliest attempt to make an explosion in a cylinder occurred as early as 1678. Gun powder was then being used for warfare, and some man attempted to turn it into a prime mover. As it was a solid fuel, apparently it was not a success.

Steam came along in the meantime, developed by the famous James Watt, and superseded the explosive type of engine. The steam engine was developed for factory use, for railway use, for ship

propulsion, for pumping, for mining and eventually for generating electric power, generally driving by belts or ropes. As is well known, the slow speed steam engine was developed in large units up to several thousands of H.P. It was apparently owing to this successful attempt that the explosive type of engine was entirely neglected.

Dr. Watson discovered that gas could be distilled from coal; and in 1792 the Cornish engineer, Murdoch, made a practical application of coal gas for lighting purposes and again the internal combustion engine became the subject of experiment. Following this, between 1791 and 1801, three patents were taken out, with a view to the use of an explosive mixture of gas and air in an engine. (The first by John Barber in 1791; the second by Street in 1794; and the third by Lebon in 1801.) Another was taken out in 1823 by Brown, and from 1823 to 1838 apparently nothing was done.

In 1838 Barnett attempted to use the principle of compression in a single acting cylinder, with separate gas and air pumps, using three pistons. This again was apparently not a success and up to 1860 nothing of practical value was done. In 1860, Lenoir, of France, commenced what was really a successful attempt to make an internal combustion engine in those days. It had quite a large sale, although the consumption of gas amounted to 100 cubic feet per H.P. In the same year two Italians, Barsanti and Matteucci, constructed engines but they never passed the experimental stage.

The development by another French engineer, Beau-de-Rochas, in 1862, actually formulated the well-known 4-stroke cycle, which afterwards became known—as it still is—as the " Otto " cycle, for in the following year, 1863, Otto made a much more practical development, and in conjunction with Langen put a number of engines on the market. They were not altogether successful, but in 1876 Otto brought out an entirely new design, which was really the first reliable combustion engine, hence the association of the principle with his name. From then onwards the gas engine became the serious competitor against the small steam engine. I should like you to take a note of the date—1876—because the " Otto " patents never became valid in any other country except in Britain.

Crossley Brothers of Manchester obtained the " Otto " patent rights in Britain, which were upheld in many law actions, and they existed until 1890. The reason was that no publication was made of Lenoir or Beau-de-Rochas designs in this country, nor was there any record in the British Museum. I was told this by my old chief and predecessor, John Henry Hamilton; so the " Otto " patents stood, as they had a monopoly. (Prof. William Robinson, Nottingham, stated " these decisions are a great blow to the gas engine industry in this country ").

English Attempts to Overcome the Otto Patents.

During the period when the "Otto" patents were held in this country, many attempts were made by English inventors to design internal combustion engines of a type which would get round the patents, amongst them being:—

(1) James Robson—1879.

(2) D. Clarke (afterwards Sir Dugald)—1881. Two-stroke displacer type. In 1876 Clarke found an Otto and Langen gas engine at work in Glasgow and it was supposed to be the largest gas engine then in Great Britain. It was of 3 H.P. capacity! He referred to the violent shocks and vibrations felt whilst it was working, even as far as 40 to 50 feet away.

(3) James Atkinson—1881. Differential type. James Atkinson, in his early days, was a designer of gas engines for Messrs. Manlove, Alliott & Co., of Nottingham, which firm still exists. I was told by one of their old staff that they had made engines up to 400 H.P. The late T. H. Barton was employed on the Atkinson engine at Manlove, Alliotts in 1884.

(4) John Henry Hamilton—1887/8. Designed the Beck 6-cycle. I will tell you more of Hamilton's work later.

(5) Hugh Williams—1887. Designed 2-stroke Stockport vis-a-vis.

(6) Charles Linford (Leicester). Designed a 6-stroke cycle.

(7) Hugh Campbell (Halifax).

Sir Dugald Clarke did a lot of experimental work, and one of his chief assistants for a period was John Henry Hamilton, in research on gaseous explosions in closed cylinders. Hugh Campbell succeeded Hamilton as Sir Dugald's assistant.

My own first impression of seeing a gas engine—and it is astonishing how it remains in my memory—was when I was in accountancy work in London in the early nineties, and one of our Lincoln firms, Robey and Co., set up a small gas engine, which attracted considerable attention, in a showroom in Cannon Street.

Another personal point is that before leaving London I worked as an accountant and assistant secretary in Queen Victoria Street to a well-known City man who held the secretaryship for many companies. I left there in August, 1898, to join the Premier Gas Engine Co., Ltd., at Sandiacre. This Company had only been formed two or three months, and within a few weeks I was sent up to London to go through the London office accounts, which office was also in Queen Victoria Street, almost facing the office I had just left! So that gave me a link between London and Sandiacre.

The Meeting with Hamilton.

I had been engaged, in London, by the then secretary of the Premier Gas Engine Co., and sent down to Sandiacre in August,

1898, as their principal book-keeper. I arrived late in the afternoon when the works and offices were closed, and made my first acquaintance with Hamilton. He was the only person in the place and was sitting in his drawing office having tea—he was working overtime on his own sketches and designs. He was surprised that an accountant had been engaged and at once asked me what knowledge I had of engineering. I admitted I had none, so he immediately told me I was no use. As I had been engaged by the secretary of the company (then in London) at the instructions of the chairman, I remained.

The next morning I went in to take up my duties and Hamilton introduced me to another clerk—who is still living—and they had to search to find the new books which had been sent in to keep their records. The Company had been registered since May, 1898, and not a figure was inserted in any of the books! In fact, they were brought to me still wrapped in the brown paper in which they were despatched from the suppliers at Derby. I gave myself a month to stay at Sandiacre!

Hamilton had no use for me until after the secretary's death in 1905 when I was made secretary *pro tem.*

I was taken round the works on my first day and shown Hamilton's original scavenging gas engine driving a part of the works. This engine, which has since become historical, is shown in Fig. 1.

A second engine, also scavenging type, was just being installed in the works. Both were single-cylinder type engines with differential pistons. As mentioned, Hamilton designed and made the Beck 6-stroke engine before 1890. Although it had two additional and so-called idle strokes, it was proved that one of these extra strokes expelled the products of combustion, and when the next impulse occurred, the mean pressure in the cylinder was considerably higher than usually obtained on a 4-stroke engine. Governing was of the "hit and miss" type, and mean indicated pressure after a miss went up to 120 lb. This brought about Hamilton's scavenging patent No. 6015, of 1890, when using the 4-stroke cycle after the " Otto " patents had expired.

He employed a differential piston, the large end being used to compress and pass a charge of lightly compressed air through the cylinder after the exhaust stroke. He also arranged an overlap by closing the exhaust valve later and opening the air admission valve earlier. In later years the differential piston was altered to a separate piston and cylinder as the reciprocating parts became too heavy.

In 1940 Mr. W. A. Tookey, the well-known London consultant, wrote an article which appeared in *Engineering*, giving the history of " Fifty Years of Pressure Scavenging ". This covers most systems of what is to-day called " supercharging " (a bad word, incidentally, as it could be understood to be overloading). Mr. Tookey gave many technical points on Hamilton's early patent, and his article was

followed by a long and varied correspondence by a number of writers, with many diagrams and tables. To-day, the proper term in the industry is " pressure charging ".

The Premier Gas Engine Co., in 1898, had taken over from Wells Brothers, and were then making a 150 H.P. single-cylinder scavenger engine for the Clydebank Engineering and Shipbuilding Company, now the famous firm of John Brown & Co. This was the largest single cylinder engine, then, they had ever made. Wells Brothers had made some tandems with the front piston of differential type. Premier Gas Engine Co. subsequently took on two 250 H.P. single-cylinder engines for Armstrong Whitworth, of Elswick, Newcastle-upon-Tyne. They were installed at a new works at Scotswood, which they laid down for the production of munitions for the Boer War. One of these is still working, I believe, at Cam, near Stroud.

A Controversial Paper.

Premier Gas Engine Co. had also taken over for Brunner Mond & Co., of Northwich, the contract for the large Tandem Scavenger engine (650 H.P.) with differential front piston, which became the subject of great interest and much controversy in Mr. Herbert A. Humphrey's famous paper at the Institution of Mechanical Engineers in 1901. Messrs. Brunner Mond & Co. had ordered two large gas engines, one from Wells Brothers (Sandiacre)—tandem type—and one from Crossley Brothers, of the vis-a-vis type, and it was in giving the results of these tests on Mond Gas that Mr. Humphrey created such a fine discussion.

Originally, the paper was meant to be read and discussed in one evening, but the discussion had to be continued on three evenings. The paper was read on 14th December, 1900, with Sir William H. White, President, in the chair, and it was assumed at the beginning that the discussion on the paper would finish that evening. In the report of the proceedings it was stated, however, that the discussion on Mr. Humphrey's paper would be adjourned for the January meeting.

The January meeting happened to be the 44th Annual General Meeting and the new President, Mr. William Maw, was elected. In opening the discussion Mr. Maw stated that as such a large number of communications had been received from members, it would be quite impossible to complete the discussion that evening. It was decided that if the discussion should not be finished that evening, a special meeting would be held three weeks from that date, February 8th.

Altogether the paper and discussion took up 216 pages in the Institution's proceedings, and much of it was devoted to the two gas engines previously referred to, and also to the working of the

Mond Type producer plant. I have a copy of Mr. Humphrey's paper, and the number of participants in the discussion is really amazing; many of the speakers subsequently became famous in the engineering world.

At the second meeting there were 353 members and visitors, and at the third meeting 180, most of whom apparently wished to take part in the discussion.

Incidentally, Prof. William Robinson's comments were some of the most important on the paper, and he gave a considerable amount of scientific data. Crossley Brothers' chief engineer at the time was James Atkinson (originally with Manlove, Alliott & Co., of Nottingham). He and Hamilton both debated matters vigorously.

In concluding his reply to the paper, Mr. Humphrey stated that the discussion had been of such unusual length that he had to confine his reply almost exclusively to his critics, but if so it was not for lack of appreciation of the remarks of other speakers. During this discussion, which I have recently read through again, two remarks come home to me:

(1) by Prof. Richard Threlfall, who said that the next generation would certainly begin to feel the pinch of scarcity of coal in this country as compared with favoured locations in America, and perhaps Australia and China.

(2) by Mr. J. H. Hamilton, who used these words: "the problem of saving coal, which is our national capital, is pressing and vital, because its successful solution means not only our greater prosperity, but a postponement of the inevitable day when lack of coal will paralyse every industry."

Mr. Humphrey will always be remembered for his papers on Gas Power Plants and Gas Engines, and also for his internal combustion pump of novel characteristics. This pump was originally made without pistons and flywheel, the pumped water fulfilling these functions. A large plant was put down at Chingford, now part of the Metropolitan Water Board and I believe is still working.

Replacing the Large Steam Engine.

Apparently the principal object at that time, in designing and making large gas engines, was to replace the large type of steam engine used in factories, mines, and other directions. As Hamilton had been a steam engine designer with the well-known firm of Douglas & Grant, of Kirkcaldy, and had designed engines up to 4,000 I.H.P., he followed much the same lines with his gas engines. He made new type tandem engines with two cylinders, developing up to 1,000 H.P., and also twin tandem, from 1,000 to 2,000 H.P. with cylinders up to 38 in. diameter and 48 in. stroke. His original

tandem was scavenged by the front piston which was differential and was of the type put down by Brunner Mond & Co., and mentioned in Mr. Humphrey's paper. Subsequently he altered this type by making a separate scavenge pump and cylinder (*a*) with an inclined piston and (*b*) later changed to horizontal piston. As already mentioned, the reason for this change was that the tandem type of engine, with heavy differential scavenger piston, had its limitations. The weight of the reciprocating parts compelled him to reduce the rotational speed. The new type was immediately successful and while the rotational speeds employed would be considered low to-day, they were then criticised on the grounds of being too high and the design too light for the power developed. Hamilton had not patented his scavenging system on the Continent and many German makers copied his process and used it to great effect in later years.

The first of the large size 2-cylinder, 1,000 H.P. tandem was coupled to a blowing-cylinder, all three cylinders in line, and was installed in 1902 at the works of Alfred Hickman, Ltd., of Bilston, Staffs.—now Stewart & Lloyds, Ltd.—and as far as I know is still in operation. Hamilton designed and made the blowing cylinder at Sandiacre and the air for scavenging was taken from the blowing side. This, of course, absorbed some of the blast air, and later on, alteration was made by fitting separate scavenging systems so as to increase the air output. Incidentally, Hickman's also placed an order for a blowing engine at the same time with Crossley Brothers, which they made of the vis-a-vis type with blowing pistons similar to Hamilton's differential pistons of the scavenger type.

The Premier engine fulfilled its duties satisfactorily. Hickman's subsequently ordered over 20 large Premier gas engines for running on blast furnace gas, all of which, with one exception, I believe, are still working to-day. They have certainly worked at full load through many years. The contracts for blowing engines only allowed a stoppage of 10 hours per fortnight for adjustment and cleaning and except for this short period they had to work day and night continuously through the year.

The engines for Hickman's first electric power were three 2-cylinder tandem driving D.C. generators by ropes, each of 400 H.P. In the large engines of slow speed type Hamilton introduced piston water cooling, of which, I understand, he was the pioneer. Again, he was also the pioneer of vertical admission and exhaust valves, facing each other on horizontal cylinders. Hamilton also took on a contract for alterations to improve the Crossley Blowing Engine at Hickman's. Later, he also undertook a fairly large contract for reconstructing engines at a big cement works of another Manchester competitor.

A New Association is Formed.

As there were so few English makers of large gas engines, the continental makers obtained a footing in this country, and their policy in those days was to cut prices. However, through the instrumentality of the then managing director of Crossley Brothers (D. Hastings Irwin), a combination was made which was termed "The Association of British Manufacturers of Large Gas Engines", and subsequently several German makers were induced to join this Association and a price arrangement was made. Each enquiry was notified and conferences were held before prices were quoted. It was my job at that time to attend a number of these conferences, and a certain percentage of the price was put into a pool to cover the expenses of the Association and make a distribution by means of a loser fund to those competitors who did not get the contracts. This Association did not deal with powers under 500 H.P. During two of the three years which I remember it existed, no firm obtained any contracts except Premier Gas Engine Co.; consequently they paid the whole of the loser fund, eventually objected to it, and insisted on the fund being reduced. The Association then quickly dissolved. Subsequently a number of English firms took up licences for German and Belgian makes, as follows:—

Mather & Platt, Manchester—Koerting.
Galloway's, Manchester—Erhardt and Sehmer.
Lilleshall Co., Oakengates—Nurnberg.
Beardmore, Glasgow—Oechelhauser.
Richardson Westgarth, of Hartlepool, took up a licence for the Cockerell, a Belgian gas engine.

Although the majority of Premier installations installed by Hamilton were successful, some also were failures. An early difficulty was the failure of some engines at Battersea in London. Having been a steam engine designer, he designed some large single-cylinder engines of the scavenging type with differential piston, each developing about 150/160 H.P., on his old steam engine lines, namely, with only a single line bed plate, with one main bearing and an overhung crank and crank pin.

The bedplate broke through stresses imposed on it and he then replaced it with a horse-shoe type of bed plate, keeping it to the single main bearing and the same crank and crank pin. Again the stress broke the bed plate and the engines were thrown out. He never repeated the design and always in future made even small engines down to one H.P. with a rigid bedplate containing two main bearings and a double web crank.

A most unfortunate trouble took place afterwards at a large works in Lancashire. The Premier Gas Engine Co. supplied them with several single cylinder 150 and 250 H.P. engines of the

scavenger type, and also 2-cylinder twin engines of 300 H.P. with differential pistons, and as these had run so successfully, they decided to go in for much larger plant. They needed a number of units developing electric power which would each give 2,500 H.P.—these units of power to consist of two twin tandem engines of 1,000 H.P. each and one single tandem of 500 H.P. Altogether, contracts were placed for three units totalling 7,500 H.P.

An Unfortunate Liaison.

In erecting the first unit the 500 H.P. engine was put in first and drawings of the layout prepared and pipework supplied under Hamilton's supervision. This engine was set to work and proved satisfactory and in order to expedite matters, the clients' engineers suggested that they should lay out and make the pipework, or get it made locally themselves for the larger 1,000 H.P. units. I could never find out what occurred in planning the pipework for these units, but a terrible mistake was made. The two large engines were erected and put to work, but only ran for a few hours before serious trouble occurred. The breech ends expanded and caused the joints to leak, both under compression and expansion. Many fractures to liners, breech ends and exhaust valve casings took place, and there were constant replacements every few weeks. The clients engaged permanently one of Premier Co.'s erectors—a very good engineer—but this did not help matters. Hamilton sent his own staff to stand by and made visits himself two or three times a week, but there was no improvement. The second unit of 2,500 H.P. was made, but owing to the difficulties of the first unit, No. 3 unit was suspended.

After many months of these difficulties the works manager from Sandiacre happened to go to the site, went into the exhaust chambers under the engine-house, and found the whole trouble had arisen through no expansion joints being fitted to any of the exhaust pipes of the first two engines of the 1,000 H.P. size. (They had been fitted to the 500 H.P. engine.)

Hamilton was blamed by the Directors of the Company for not discovering the cause himself.

I was present at many discussions and eventually the clients decided to start a law action against the Premier Gas Engine Co., as their production had failed considerably through these engine difficulties. It is one of the outstanding events in my engineering experience that such a simple omission occurred and was not found out for nearly a year after starting up. However, litigation was avoided by a compromise, and the engines of the second unit were retained at Sandiacre and the parts subsequently used in other productions. No further contracts were obtained in this particular Lancashire industry owing to this event and it shook the big gas engine trade in this country for some time.

Financial Difficulties.

During the first four or five years the Premier Gas Engine Co. suffered heavy losses, some due to its gas engine troubles, but mainly due to the uneconomic situation in that the prices they quoted were entirely wrong. In those days Hamilton himself made up the estimates, assisted by a clerk, and I was puzzled that the end of every financial year showed such a noticeable deficit. I personally got out many overhead calculations which showed that their method of dealing with overheads was wrong, but these were not accepted by the then secretary of the Company or by Hamilton.

When the secretary died in 1905, I was appointed secretary *pro tem.*, and one of my first actions was to tell the Chairman why the financial position was so bad. He objected to my criticism, but eventually gave me a certain amount of liberty to reduce unproductive charges and where necessary to increase the overheads. when making up estimates for new contracts.

It was during this period that offers were made to buy up the Company by Worcester and Sheffield firms. Each made an offer of £30,000 for the Company's assets lock, stock and barrel, but as we owed nearly double that amount to the Bank, the offers were not accepted. During this bad time the Company was being sued in the County Courts for being behind with its payments and I had the experience of going through County Court actions.

Fortunately in my first year as acting secretary we turned the corner and never once since has the Company been on the wrong side financially. In addition to the financial side, I took over all the commercial work, including the sales side. In order to be competent for this work I had to sit most mornings with Hamilton whilst he went through the letters. During the whole of his life he never dictated one letter. His method was to write all his correspondence in longhand and then give it to a typist but I changed this.

I listened for many years, each day, to his discussions on correspondence (which almost took the form of lectures) taking notes in shorthand. Then I used to dictate them to a male shorthand typist and submit draft letters for approval to Hamilton. These he would correct and send back for re-typing.

Devising a Costing System.

I should also like to mention that in these early days I had as assistant in the Company for several years, Mr. C. W. Reeve, a Nottingham man. He came originally as a temporary assistant, being introduced by the then Nottingham Clerks' Association. He was very keen on costing systems and together we drafted a system of costing which would dovetail into financial accounts. As we had no calculating machine or mechanical accounting in those days, it

all had to be done by pencil and pen and we could not get the two systems to balance exactly. They did so, however, within a small percentage.

Mr. Reeve subsequently left and went to the British Westinghouse Co., of Manchester, and afterwards to the Associated Equipment Co. In the latter company he rose from cost accountant to general accountant, from general accountant to general manager, then to managing director and then to chairman, in succession to Lord Ashfield who became Chairman of the London Transport Board.

The Chief Engineer of his company, Mr. Dicksee, gave the 8th Ackroyd-Stuart lecture in Nottingham. A few years ago the Institution of Production Engineers published a very fine book on "Organisation and Control of Production", which was a paper presented to the Institution by the Associated Equipment Company, Ltd., an affiliated firm.

A Period of Failures.

There were many failures in this country of large gas engines and gas plants. One installed in a textile factory in Nottingham by a Lancashire firm was a very serious one and the engine and producer plant were thrown out. Nottingham factories never again went in for gas engines. The same firm had a second failure in Wales. Similarly, a large plant put in by another Lancashire firm was installed at a textile mill in Cheshire. It was replaced on two occasions, but in the end proved to be a failure.

A large firm in the Midlands had failures in two plants in the South of England. The three firms just referred to almost immediately stopped making gas engines. The worst failure of all, however was experienced by a firm who put down some large gas engines with German producer plants in South Africa. For many years afterwards, it was very difficult to obtain contracts for large gas engines.

One of the singular things about early days of the large gas engines was the fierce controversy about driving electric generators. As I have previously mentioned, in those days practically all electric generators were of the D.C. type and were driven by belts or ropes, either from the flywheels of the engines or from pulleys. The D.C. sets driven in this way did run in parallel, but in most cases then the users would not accept direct coupled sets for D.C. As to running A.C., this was entirely out of the question; and it seemed to have been definitely decided in the discussion on Mr. Humphrey's paper that it would never be possible to run A.C. machines from gas engines, either belt or rope driven, and certainly not direct coupled.

At a later stage, in discussion before the Institution of Civil Engineers in 1909, Mr. Humphrey stated some of his experiences and referred to those days when no makers of dynamos (apparently

D.C.) could be found who would guarantee the running of their machines if direct coupled to a gas engine. He also stated that one firm with a familiar name assured him that no generator could be built to withstand the repeated shock from the irregular working of a gas engine and that the insulation would inevitably break down.

Direct-Coupling of Dynamos.

I think Hamilton was the first man to arrange for a direct-coupled dynamo to a gas engine, but he took a great risk. As I have stated before, direct coupling to A.C. was considered out of the question, but Hamilton, I feel sure, was a pioneer in this direction. He did install an engine in Holloway, London, with an alternator bracket mounted on the flywheel arm (it did not run in parallel with the other sets).

Another early memory is the first instance when the Premier Co. put down a public power plant as sub-contractor to a well-known electric company. This consisted of a 14 nominal H.P. gas engine, driving a D.C. generator by belt. I have used the term "nominal" as it was in general use in the gas engine trade in the early part of the century.

During the period when engines were being coupled to D.C. machines, Hamilton abandoned "hit and miss" governing and commenced variable admission. Hamilton's method was governing on the gas admission only, not gas and air, and I think he was the only one to develop this method.

After having successfully coupled a gas engine to a D.C. machine for the late C. H. Wordingham, later Electrical Engineer to the Admiralty, the then managing director of Messrs. Bruce Peebles & Co., Ltd., came to Sandiacre, had a discussion with me, and stated that there was a large potential field for engines coupled to alternators to parallel, and left me with a definite enquiry. Hamilton was away but I mentioned this to him on his return and he went into deep thought. The only question he brought up then was of cyclic irregularity. About the same time the Premier Gas Engine Co. was doing a contract for gas engines coupled to D.C. generators for Spain, using suction gas for the first time and the producers were of the "Industrial" suction type, designed by the late Stainer Hutchins, who was then with a Manchester firm and was a keen electrical engineer as well as a gas producer expert.

I remember Hamilton and Hutchins discussing how the question of paralleling of direct coupled alternators to gas engines could be made a success. Hutchins emphasised the fact that apart from cyclic irregularity, alternators should be damped or, to use his own phrase, "choking coils" should be inserted. A contract was taken for two sets of engines and alternators for Japan with Peebles

Machines—(Kankoku Gas and Electrical Co.)—and these were 4-cylinder "Otto" cycle engines. Owing to the difficulties of manufacture, Hamilton split the engine into 2×2 cylinders, with central flywheel and mounted the alternators on brackets cast on the flywheel arms, similar to that previously mentioned.

This emphasised two points: (1) that splitting the 4-cylinder engine into two pairs of two cylinders avoided torsional oscillation, and (2) the bracket mounting of the alternator also avoided vibration, as it brought the alternator and flywheel into one revolving mass and this system has been extensively used in hundreds of cases since with great success. Hamilton did not consider any method of damping in this particular case, but the sets did run successfully in parallel. I shall refer to difficulties in paralleling later. Hutchins afterwards joined the Mond group of companies and then left the group to take control of Electro Bleach and By-Products Ltd., which afterwards came back into the Mond Group (now I.C.I.).

Pioneers of Producer Gas.

I met several pioneers of the producer gas method at Sandiacre, such as J. Emerson Dowson, Dr. Ludwig Mond of Brunner Mond & Co., Stafford Walker of Bristol, who made gas producers similar to Dowson type; Hutchins, inventor of the Mersey type producer, also Whitfield of Kettering, who put down a number of producer plants in India, using wood as fuel. I also remember that the chief engineer of a prominent company of cement manufacturers installed a double draught producer, that is, up and down draught. Many of the main parts were made from concrete.

Hamilton's experience in using producer gas in engines covered a very wide field. Most of the early engine makers used town gas only. Dowson invented the pressure type gas producer for utilising anthracite and coke, the first installation of which was, I believe, put down to drive Messrs. Crossley Brothers works at Manchester.

Hamilton also used this method of gas production for many of his smaller plants. At that time 100 H.P. was a large size unit and this was about the maximum capacity of the Dowson producer.

A pressure plant for using bituminous coal was put down at Sandiacre, this being Dr. Ludwig Mond's invention. The original was installed in the Brunner Mond works at Northwich. The main principle of the Mond producer was for production of sulphate of ammonia, the gas being a by-product. (The price of Linby Top Hard slack, which was used in the Mond plant at Sandiacre, was then 2/9 per ton, delivered.)

It was at Northwich that the two large engines about which Mr. Humphrey wrote so much were installed, to run on Mond gas. In order to test the large engine at Sandiacre, a small plant (1,000 H.P.) mentioned before, was put down. At that time it

could not be purchased and Dr. Mond issued the drawings from his own London office to Hamilton. Parts of the plant were made by Nottingham boiler makers and other parts by Hamilton himself at Sandiacre.

There is another Nottingham connection here. The Mond gas plant at Sandiacre was supervised and installed by Arthur H. Lymn, who eventually joined Power Gas Corporation Ltd., which company Dr. Mond formed to sell his gas plants. Arthur H. Lymn is a brother of the well-known Freemason and Rotarian in Nottingham, Charles Lymn.

As a result of the test of the gas producer side, a great deal of data was obtained, in conjunction with the Northwich data, for putting down a large Mond Gas Producing Plant, erected at Dudley Port, Staffordshire, for the South Staffs. Mond Gas Co., which still functions in an important way, manufacturing low calorific gas for heating and power for the surrounding industrial district.

Mr. Humphrey was originally the consulting engineer for this scheme, and until recently was the chairman of the company. The plant was equivalent in size to many thousands of H.P., and many other large-sized plants were put down in this country for industrial firms and companies, and large gas engines were installed for power purposes. (Since writing my paper I have had the pleasure of a long talk with Mr. Humphrey at his home in Tunbridge Wells.)

Some Unusual Jobs.

Hamilton also designed engines for using coke-oven gas, blast furnace gas, and natural gas. One of the latter, sent to Canada nearly 40 years ago, is still in operation. He also did some peculiar individual jobs. One for example, was for Gloucester Corporation, using suction gas from anthracite fuel, where he turned some three-cylinder gas engines into a two-cylinder type, and made the third cylinder into a compressor for forcing air down to a low level (about 1,000 feet) for raising water to ground level. The consulting engineer was a personal friend of his, and like Hamilton was an Irishman. The job had to be stopped during the 1914/18 war, but was installed afterwards. Two compressor sets were put down, and in addition two smaller sets, with direct-coupled reciprocating pumps for pumping water from ground level to a reservoir.

Hamilton designed and intended to make his own pumps, but as an old friend, the managing director of a Scottish firm of pump makers, afterwards a President of the Institution of Mechanical Engineers, was willing to assist him, he made the pumps from Hamilton's drawings and I think the whole installation is still working perfectly to-day.

When contracting for special jobs, Hamilton often designed and made his own machine tools for the main parts, quite a number of

which are still in use, such as a flywheel turning and boring machine made over 40 years ago; also a large machine for planing cast iron girders for engines of the tandem type. This latter machine he called a rotary planer, similar to the machines now called plano-millers, and it is often spoken of as the original of this type. In the early days he designed and made what he called a " crank-rougher " for cutting out the solid webs of single throw crankshafts.

He also designed and made other gadgets to ease heavy labouring work, one freak type being a hoist, which he applied for lifting raw materials to the foundry cupolas, and a similar one for hoisting coal to the " Mond " producer.

Another original development by Hamilton arose out of a request by the Admiralty before the 1914 war for a gas engine for marine propulsion. The result of the enquiry was that Hamilton designed and made a slow speed gas engine of 1,000 H.P. consisting of four double-acting cylinders, working on a single crank by means of a triangular connecting rod. His own idea was to make a larger unit, but as it was to be an experiment the size was kept down to minimise the cost. Before it could be put to work, however, the 1914 war came and the job was put on one side. Looking back, it is surprising that it was not utilised.

The engine was completed in 1914 and remained in the works until 1919, when it was placed in Hickman's steel works, Bilston, to run on blast furnace gas. Many critics, including a famous consulting engineer, contended that it would not work, but an article in *The Engineer* reports that it was working successfully early in 1920 and it continued its operations day and night until about a year ago. It is illustrated in Figs. 7 and 8.

The original intention was to make a 4-crank engine of the double acting, vertical type, each crank unit developing 3,000 H.P., so that a 12,000 H.P. unit could be produced.

New Developments.

When the period developed so that gas engines could be coupled to alternators, it brought a revolution in the minds of gas engine designers. The slow speed type of engine, with large diameter cylinders, at once became obsolete and the demand was for engines with higher revolutions, and of multi-cylinder type with smaller cylinders. Similar developments were going on in the steam world. The Willans Steam Engine enjoyed wonderful popularity and many gas engine designers followed the example set by the steam engine. In fact, many of them swung right over to the medium and high speed vertical engines.

The Premier Co. also developed a vertical engine, but this was of a special type, with a stuffing box fitted in one end of a closed cylinder with a piston rod passing through, and fitted with cross-heads,

guides and slippers—again following steam practice. This design was meant to prevent crank chamber explosions, which were prevalent in the open cylinder type of vertical engine.

The chief engineer of a cement company wished to install engines of the Premier vertical type and as Hamilton did not go out to visit potential clients, I persuaded the engineer to come to Sandiacre. After a long discussion with Hamilton he decided to install engines of the horizontal, multi-cylinder type, coupled to D.C. generators. These were installed at a large cement works in Kent and, as they ran successfully, several repeat orders were obtained and were erected in many large works in the South of England. These had heavy work to do as they had to run continuously throughout the week non-stop, often working under very bad conditions, as in the neighbourhood of cement works the atmosphere is invariably heavy with dust and grit.

At a test made on the consumption of these engines by a well-known London consultant who later became President of the Institution of Mechanical Engineers, the consumption in B.T.U.'s per B.H.P. hour was reported below 7,500. Subsequently the company was expected to give this figure as a guarantee, but Hamilton did not accept the test figures and refused to give such a low consumption. He would never go below 8,500 B.T.U.'s.

The reason I have brought up the discussion with Stainer Hutchins is that in the later development of coupling gas engines to alternators to run in parallel, the question of "damping", or as Hutchins called it, "choking coils", became of great importance.

An Important Consideration.

The first case I have in mind was where two sets were put down in Devonshire, running on wood gas, and the alternators failed to parallel although the characteristics of the engines had been thoroughly gone into. The contract was carried out by an electrical company and we were sub-contractors for the engines. In order to carry out the distribution, after the failure to parallel, the electrical company had to lay down a second main cable so that each set had its own circuit. During this difficulty Hamilton had an illness and had to take some time off to recuperate, with the result that I attended the conference. The electrical engineers argued strongly before the consulting engineer that the whole trouble was due to engine cyclic irregularity, and blamed the flywheels on the engines for being too light. They insisted that if heavier wheels could be put on, the trouble would be cured. In order to ease the position I agreed to heavier flywheels, and when Hamilton returned, he smiled and said it would only make matters worse.

In connection with another somewhat similar contract, a second

pair of gas engines was tested in the works combined with the alternators, with heavy type wheels such as I had promised and they also failed to parallel.

To prove his point, Hamilton then had the heavy wheels turned down to a much lighter weight and the results were much better, although the sets still would not parallel. This again proved that cyclic irregularity was not the only problem.

In the end it was found that more damping windings had to be inserted in the alternators, for the two pairs referred to, and the machines were taken back to the makers' works and reconstructed.

Difficulties also occurred with another make of alternators in South Wales. This was a case where there was a combination of gas and electrical power at a municipal works. Again the electrical firm would not at first accept the stipulation for extra damping, and the alternators would not parallel. I happened to run across the chief engineer of the electrical company in London, and gave him the history of the previous case. During a following week-end he arranged for the two electrical machines to be brought from South Wales into the Birmingham area and by Monday morning they had been altered by increased damping and re-despatched to the site. In a few hours the sets were running satisfactorily in parallel.

Another case occurred with a Lancashire electrical firm with a gas engine contract in South Wales. Again the sets would not parallel and a new alternator had to be constructed, and one of the originals altered so as not to shut down the plant. This was during my first months as Managing Director and I had to take a very severe reprimand from the Board of Directors of the purchasing Company in London, as we were the main contractors in this case.

As the electrical company blamed the engines, Premier Co. undertook to reconstruct them if the sets failed after the suggested modification to the alternators was carried out, and also agreed to pay the cost of the alteration if the alternators did not run satisfactorily after the damping windings had been changed in accordance with our stipulated requirements.

The alternator makers carried out the changes and connected the alternators to the engines, found that the combined sets were quite satisfactory and left the job without giving notice, merely sending a telegram that all was completed. The London consulting engineer was informed, conducted a severe test, and the sets were accepted.

These examples show how much was at fault in those days on the electrical side.

Utilisation of Wood for Making Gas.

After linking up with Crossley Brothers, Ltd., in 1919, there came a big development, both for this country and for export, of multi-

cylinder gas engines, utilising wood for gas making. As these were of the straight " Otto " cycle type, the Hamilton system of scavenging was dropped. This reduced the number of cylinder sizes for standardised manufacture.

The Crossley gas plant had been very successful for generating gas from native grown wood, and the combination of the Crossley wood producer and the Premier Gas Engine brought many large contracts in Rhodesia, E. Africa, W. Africa, W. Australia, Canada, Malaya, China and Brazil. All were to drive alternators, as these became universal.

Quite recently a very fine paper was given before the Diesel Engine Users Association on the results of wood gas producer plants and gas engines driving alternators in a mining plant in West Australia. Some of the sets had been working continuously for over 20 years.

In West Africa two well-known mines have installed Crossley Gas Producer plants for utilising wood, with Crossley Premier Gas Engines for power, the total amounting to many thousands of H.P. This combination has certainly solved the fuel problem, and one sometimes wishes similar things could be done in this country. As these engines are working in tropical climates, sections of the forest are cut down and the wood utilised for making gas. Subsequently the cut down sections are replanted, thus replacing the wood originally used. In Rhodesia and West Africa the replanted sections can be utilised again after 10 or 12 years' growth.

The link with Crossley Brothers also brought Hamilton into the development of the larger sizes of the heavy oil engine, and as these were needed all over the world for electricity generation, and as A.C. became the standard type of current, the four and six-cylinder straight line type of horizontal oil engine was developed in a range of sizes. Many were put down in this country, and were also produced for a large export market. The first installation was for providing power for the constructional work on the Sydney Bridge in Australia.

Subsequently an enquiry was received for some engines of the vis-a-vis type for driving refrigerating plant on the Nelson Line fleet of ships. Mr. A. R. T. Woods, who passed away in February, 1947, was the chief engineer of the Nelson Line (which subsequently became part of the Royal Mail Line), and a controversy arose over the type of engine required. As a result the contract was provisionally placed with a competitor. Hamilton told Woods, after having seen some of the competitor's designs, that the plant would not work satisfactorily. Woods therefore changed his mind and placed his work with the Premier Co. through two refrigerating firms.

A Great Tribute.

In after years Woods paid a great tribute to Hamilton and his work. His comment was: " Those engines ran like a clock." They were of the 2-crank, 4-cylinder vis-a-vis type. Considerable help was obtained for this contract from Crossley Brothers, Ltd., through their earlier experience of the vis-a-vis type. This design was also developed by the Brush Co., Loughborough, and Robey's, Lincoln.

Following this, a 4-crank, 8-cylinder type was developed and three large sets were installed in the Middle Level Catchment area in Norfolk, for Fen drainage purposes, driving centrifugal pumps through gearing (see Fig. 9). Quite a number of other drainage schemes were carried out, one of which is in the Trent Catchment Area, installed by the Vice-President of the Nottingham Society of Engineers, Mr. Haile. This latter scheme comprises six sets of 4-cylinder, 4-crank straight line engines, pressure charged, specially designed with a longer stroke than standard for a slower speed to couple direct to centrifugal pumps, thus dispensing with gearing, (see Fig. 10). The 4-crank, vis-a-vis design became famous in every part of the world for both gas and oil engines, and hundreds of thousands of H.P. have been installed.

Hamilton retired in 1930 and died in February, 1932. After his retirement I was appointed Managing Director. The Company recommenced the scavenging (pressure charged) system in oil engines and this has proved successful in many installations. The 4-crank vis-a-vis was further developed into 6-crank and 8-crank types by splitting the units; in other words, making a double 3-crank with 12 cylinders, and a double 4-crank with 16-cylinders. The 16-cylinder type is capable of developing up to 3,000 H.P. when pressure-charged and many of them are coupled to 2,000 K.W. alternators.

Some of these large sets were introduced through the late A. D. Philips, who lived at Risley, and was well-known in Nottingham through his connection with the local power company and with a large group of electrical companies in London.

Stewart & Lloyds, Bilston, also put down a large 16-cylinder set to run on either oil or blast furnace gas. This has run continuously through the war years since September, 1939; also during this period one of these large 16-cylinder pressure charged sets was supplied for a very "hush-hush " Government job in the South of England, (see Fig. 12).

In connection with the vis-a-vis type of engine, the first put down in this country was by a Mr. Bellamy, of J. & E. Andrews, of Stockport. Two were installed at a theatre in London in 1887, and ran for many years. This firm was subsequently absorbed by Richard

Hornsby & Co., of Grantham, who afterwards combined with Ruston, Proctor & Co., Lincoln. Mr. Bellamy remained a director of Ruston and Hornsby until his death a few years ago.

Later Criticisms.

In later years the main criticism of the Sandiacre design of the horizontal engine was that it was not sufficiently enclosed. The modern power engineer, with the enclosed steam turbine coupled to its generator, does not see many moving parts. In the original Hamilton design, nearly all the moving parts were accessible from outside and there is still a great feeling in the mining world that this is preferable, providing as it does for easy renewal of parts. However, to meet the modern demand, Sandiacre have designed a new type which is almost totally enclosed. (See Fig. 13). It is to my personal credit that this new design was brought into being. A new designer was brought into the firm with assistance from a well-known Consulting Engineer, who had much previous experience in the Intenral Combustion Engine world.

The main construction includes a cylinder liner and breech-end in one piece, which is one of Hamilton's so-called freak designs but has proved very successful. Many of the other parts are still similar to those designed by Hamilton, and it is in connection with the recent contract obtained for the Iraq pipe-line for many thousands of H.P. that this newer type is being developed in 4-crank, 8-cylinder, and 8-crank, 16-cylinder sizes. This contract is one of the largest ever placed in England for oil engines.

In connection with the heavy oil engine, much to-day is written and said about supercharging or, as it should be called, pressure-charging. At first it was thought supercharging was to get a little extra power out of the internal combustion engine, but of late it has become a component part of the engine and is used throughout the whole running period. The fact remains that supercharging is an additional development to Hamilton's original method of scavenging.

Scavenging is an essential part of the process; that is, sweeping out with air the hot residual gases remaining in the combustion chamber at the end of the exhaust stroke, and then continuing the sweeping process for a definite period, by which means the internal walls are cooled and the suction stroke then commences with a combustion chamber full of clean and comparatively cool air. This latter important process is accomplished by supplying the induction air at a slight pressure above that of atmosphere, and arranging a larger overlap between the opening of the admission valve and the closing of the exhaust valve than in Hamilton's original method.

Many papers and press articles have been written on this, and one can produce dozens of references back to the original patent in 1890.

Several times in this paper I have mentioned Nottingham men and their connection with the development of the large powered internal combustion engine. I would say emphatically that Nottingham and the East Midlands have done their full share in this successful development.

Origination of the Diesel Engine.

One can never forget that the present-day so-called Diesel Engine was originated by Ackroyd-Stuart of Grantham, and quite a lot of history has been written concerning him. Incidentally he spent the latter part of his life in Australia where before he died he took a share in producing the modern producer plant of down-draught type. As I have stated before, the gas engine is still used extensively in Australia, utilising wood as fuel, and both Ackroyd-Stuart and Hamilton had a hand in this. (I rather stress this point about Nottingham engineers in the interest of University College, Nottingham, because both Ackroyd-Stuart and Hamilton obtained a great deal of theoretical and scientific information from the late Prof. Robinson who was head of the Engineering Faculty of University College, Nottingham, for many years).

It may interest members to know that Hamilton's application for his scavenging patent was applied for (No. 6015) on April 21st, 1890, and Ackroyd-Stuart's patent application for his compression ignition engine (No. 7147) was dated 8th May, 1890, so that both these men made important technical developments within a few days of each other in the Nottingham district.

Ackroyd-Stuart was almost forgotten for many years until the heavy oil engine developed from his theory, and it is a great pity that so many types of heavy oil engines are to-day called " Diesel ". Even the modern Continental engine, which is of the compression ignition type, as originated by Ackroyd-Stuart, is called a Diesel. This term is also universally used by American makers. However, Ackroyd-Stuart's name will be perpetuated by the fact that annual lectures are given at University College, Nottingham, in his memory, and as you all know, the organisation of these is in the hands of Professor Bulleid.

Another Nottingham Link.

Another interesting link with Nottingham was the late Mr. T. H. Barton. Amongst other things, it may have been noticed from the recent memoir in the *Engineer* that it was Barton who erected a Hornsby-Ackroyd engine, for which an initial order was placed by Squire Sitwell, of Smalley Hall, Derbyshire, in 1891. Barton told

me personally that he got this engine to work satisfactorily and that it remained at work on a farm near there until 1936 when he bought it and brought it to Nottingham. It is interesting to note that in order to improve his knowledge Barton worked in his early days, in the evenings, as an unpaid laboratory assistant in the Engineering Laboratory at University College, where he came into close contact with the late Professor Robinson. Barton was also the pioneer of using town gas, instead of petrol, for bus running.

Looking forward to-day, and especially after hearing Air-Commodore Frank Whittle give the 11th Ackroyd-Stuart lecture last year, it would seem that the future internal combustion engine will be of the gas turbine type. It is certainly moving rapidly in many directions and may supersede the reciprocating type of internal combustion engine, as the steam turbine has done to a very great extent with the steam reciprocating engine.

Since drafting my paper I have seen a copy of the 12th Ackroyd-Stuart lecture given by Air-Commodore Banks. His study is mostly for large power units of future aircraft, but naturally I am interested in this type of prime mover for stationary work.

I have been told by a prominent London consulting engineer that there is a gas turbine of 27,000 K.W. on order, which is guaranteed to give a full load overall efficiency of 34 per cent. If this figure is reached, it will be an exceptionally good one from the efficiency point of view, and certainly no reciprocating oil engine could be contemplated to give such a big output.

(Mr. Gibbons' talk was accompanied by a number of photographic slides, for the loan of which thanks are due to the Crossley Premier Engine Company Limited.)

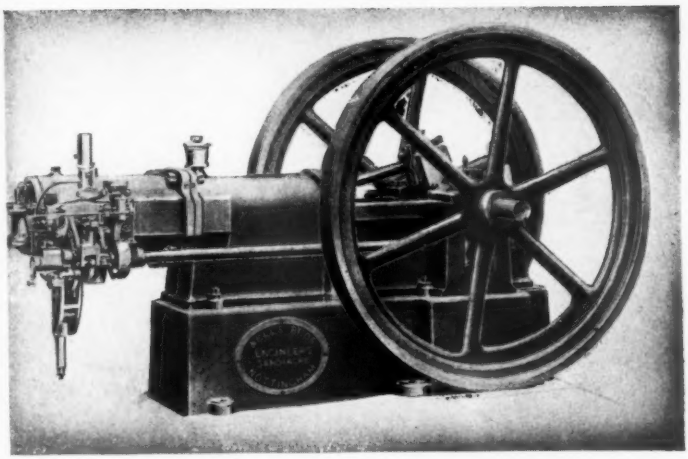

FIG. 1. Hamilton's original Scavenger Engine with Differential Piston, made by Wells Bros.

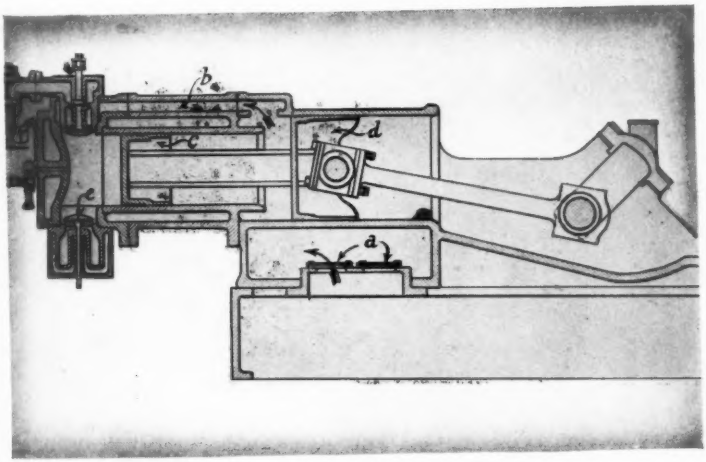

FIG. 2. Section through Hamilton's later design of Scavenger Engine with Differential Piston, but with Vertical Admission and Exhaust Valves, also made by Wells Bros.

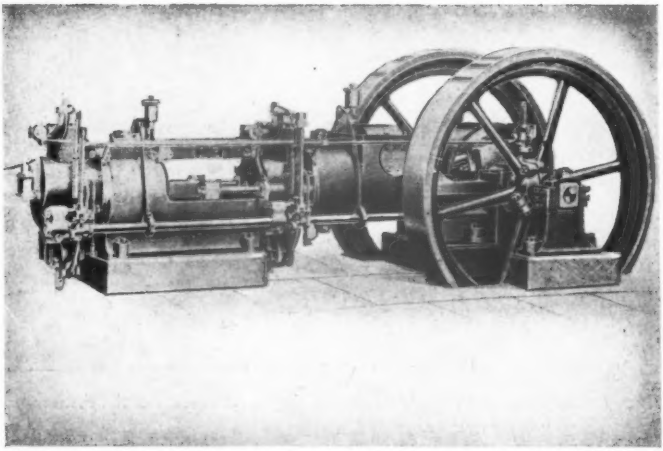

FIG. 3. Tandem Scavenger Engine, with Front Differential Piston, made by Wells Bros.

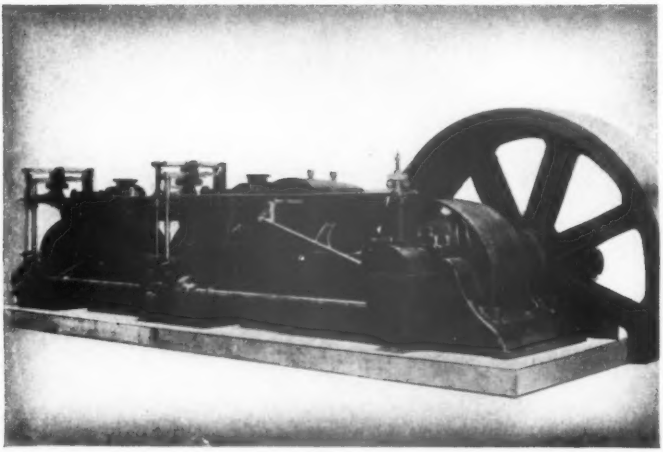

FIG. 4. 530 H.P. Tandem Scavenger with Front Differential Piston, as supplied to Brunner Mond & Co., Northwich, in 1900, and made by Premier Gas Engine Co.

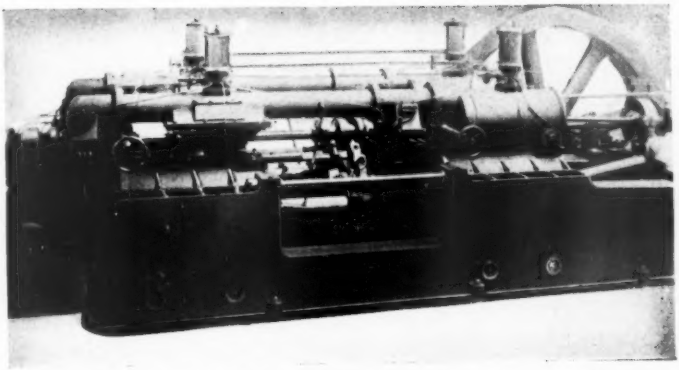

FIG. 5. Double Tandem Engine with separate Scavenger Pistons, 1,000 H.P., made by Premier Gas Engine Co.

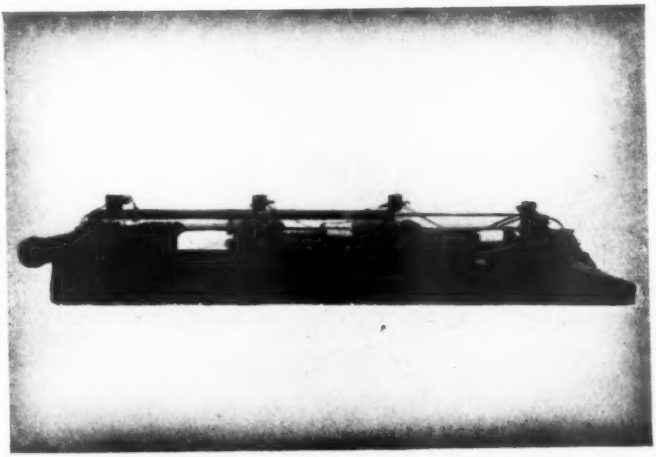

FIG. 6. Single Tandem Engine, 1,000 H.P., with double-acting Blowing Cylinder. Impulse Scavenging to working cylinders from blowing cylinders (no flywheel shown).

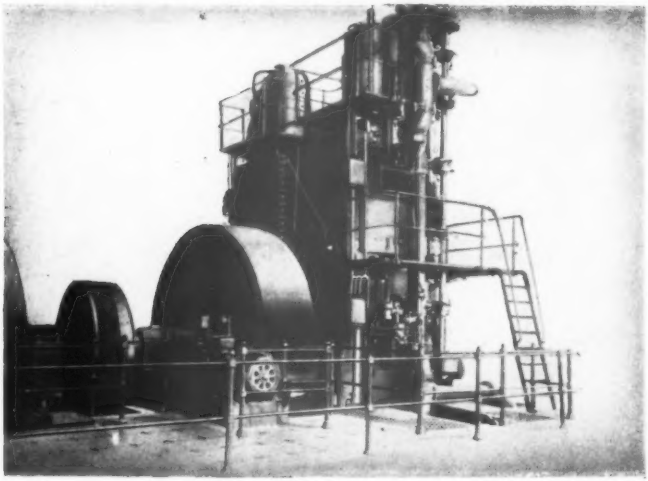

FIG. 7. 1,000 H.P. Single-Crank Marine Type Engine with four double-acting cylinders working on one crank.

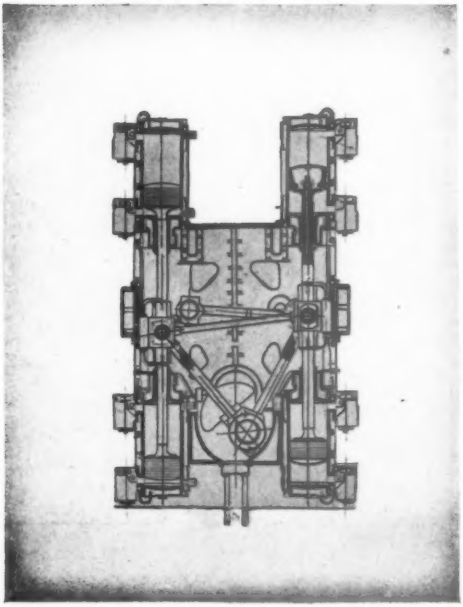

FIG. 8.
Section through Engine shown in Fig. 7.

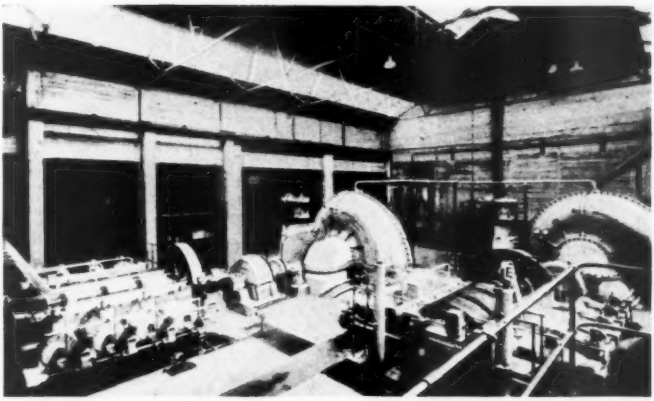

FIG. 9. Middle Level Drainage Board—three 1,000 H.P. Vis-a-vis Oil Engines driving centrifugal pumps through gearing.

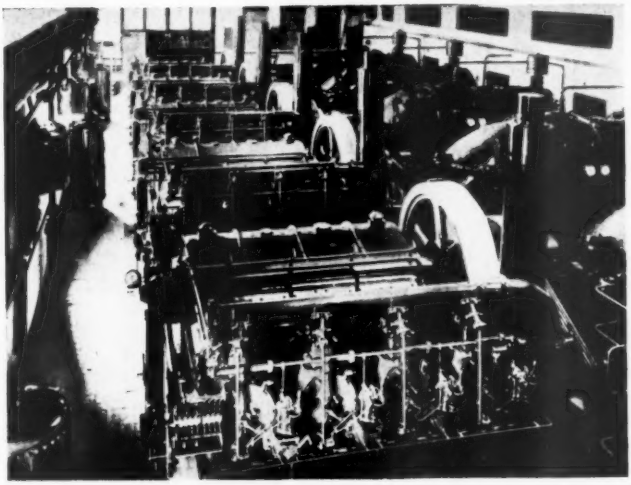

FIG. 10. River Trent Catchment Board—five Straight Line Pressure Charged Oil Engines direct-coupled to centrifugal pumps.

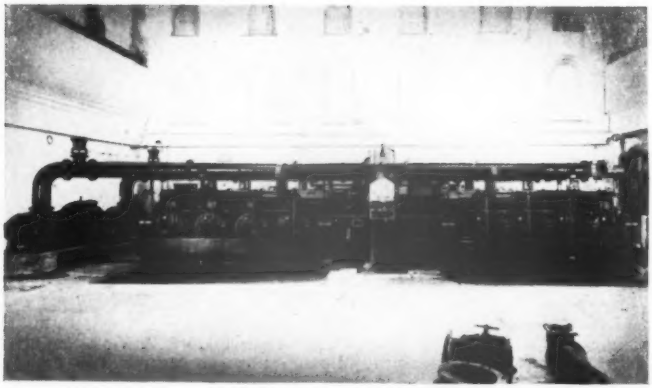

FIG. 11. Twin Four Crank Vis-a-vis Oil Engine with Sixteen pressure-charged cylinders, coupled to Alternator, in Jerusalem Power Station.

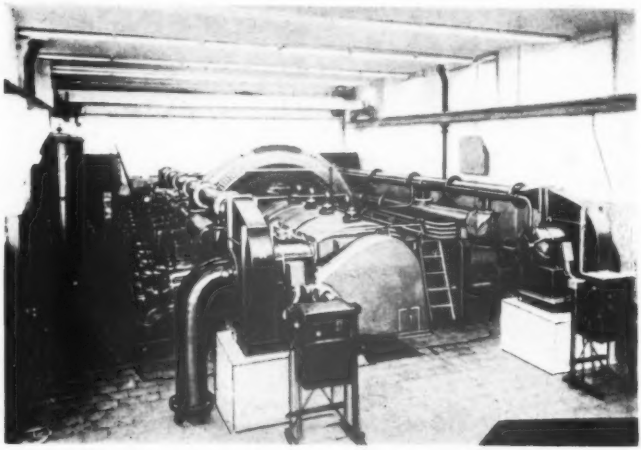

FIG. 12. Engine and Alternator of similar size and type to Fig. 11 installed in a special Government station.

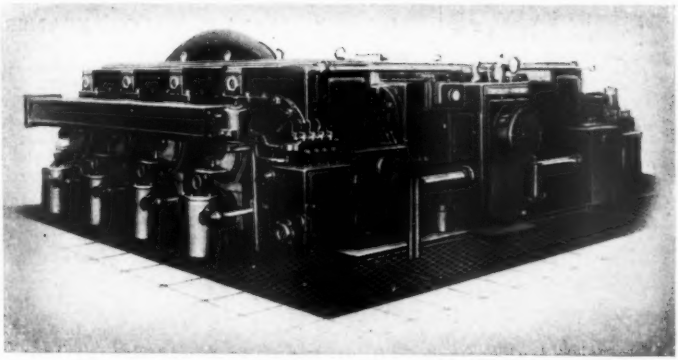

FIG. 13. Four Crank totally enclosed Vis-a-vis Oil Engines of eight cylinders, of the type being supplied for the Iraq Pipe Line.

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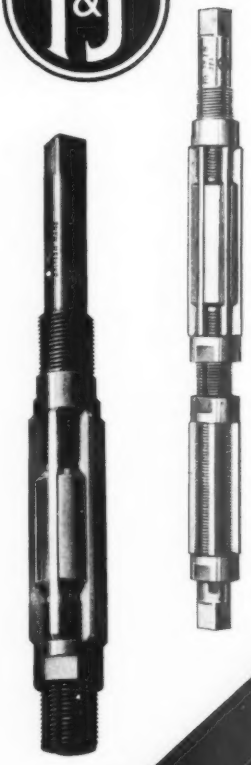

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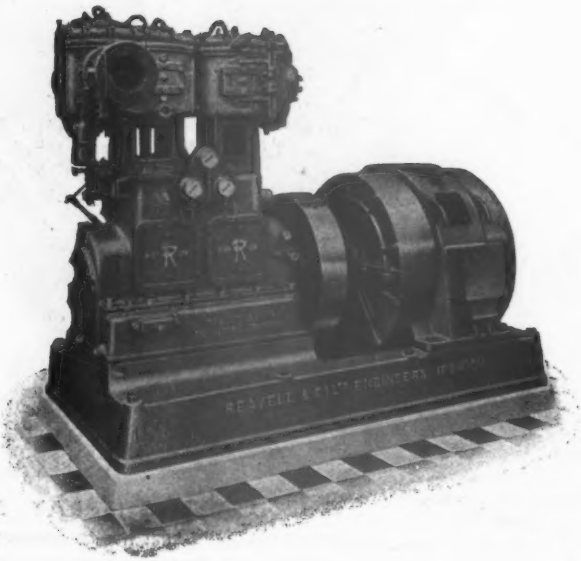

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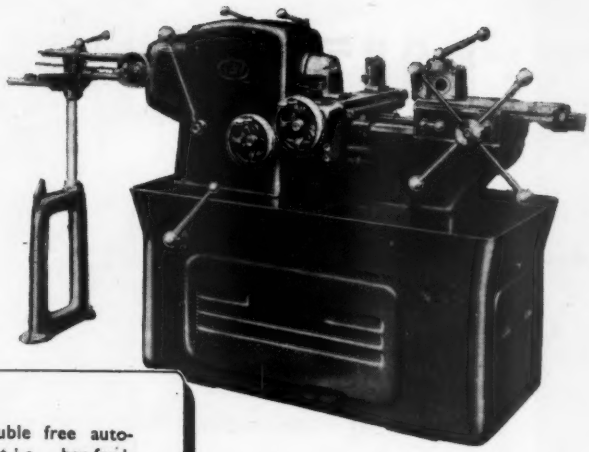

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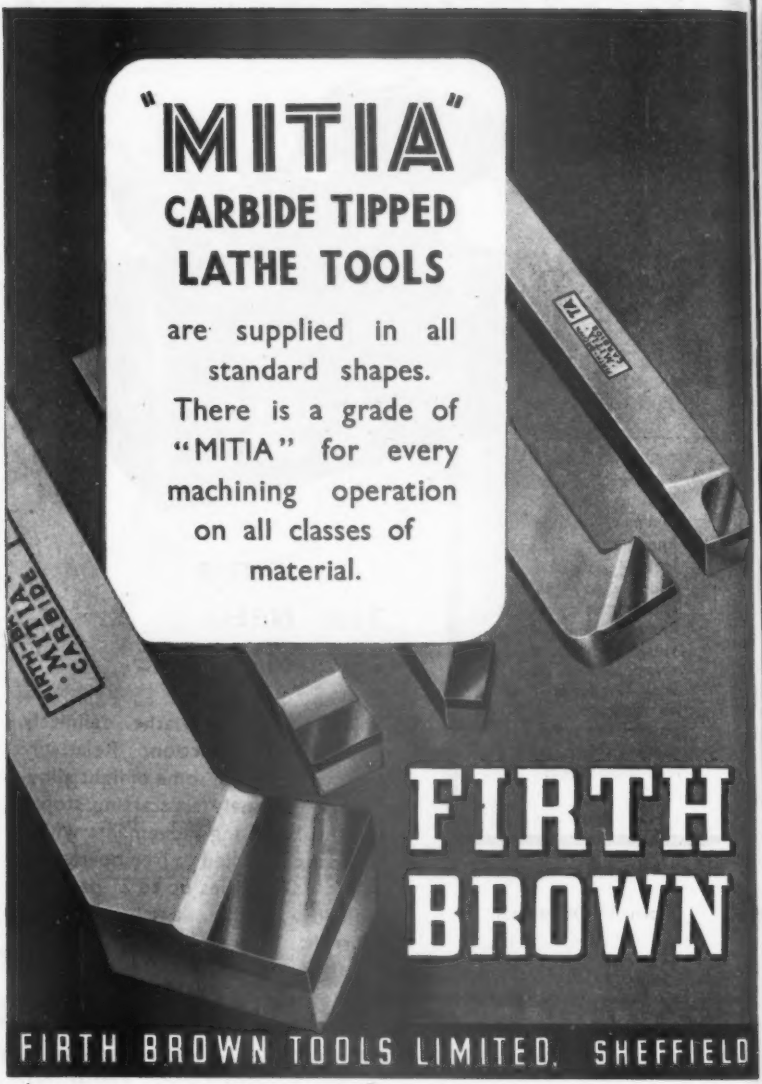
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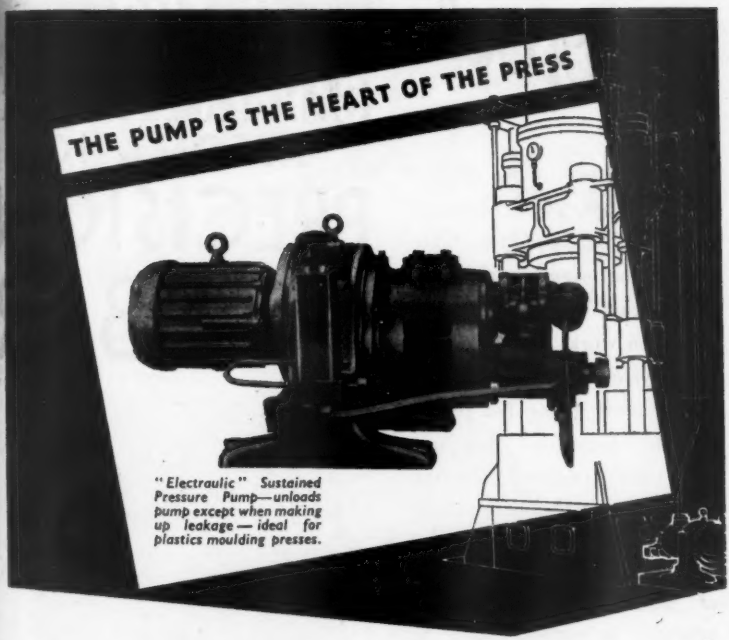
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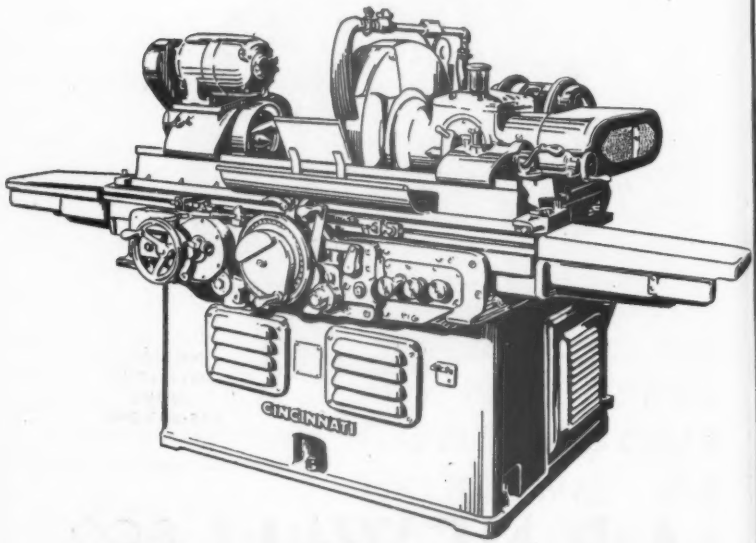

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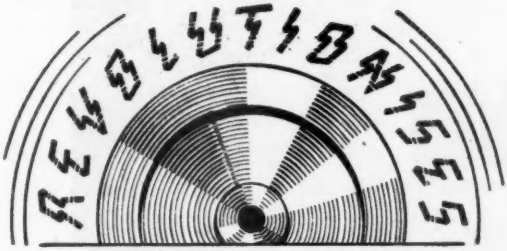

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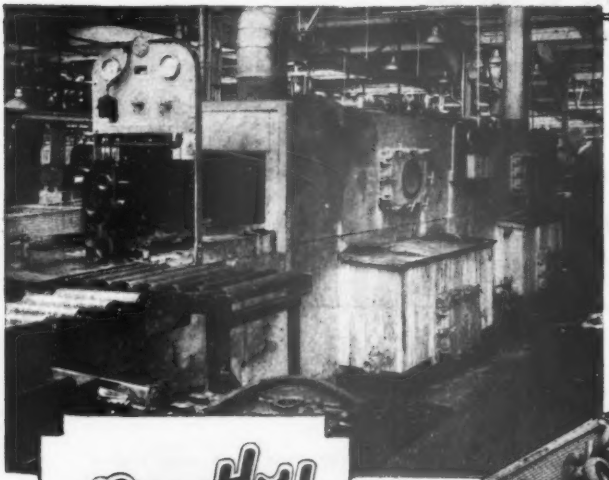

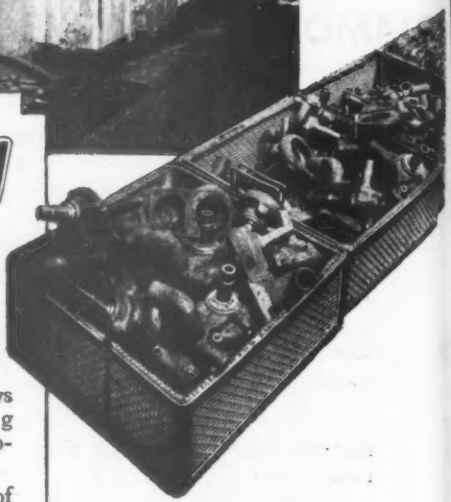

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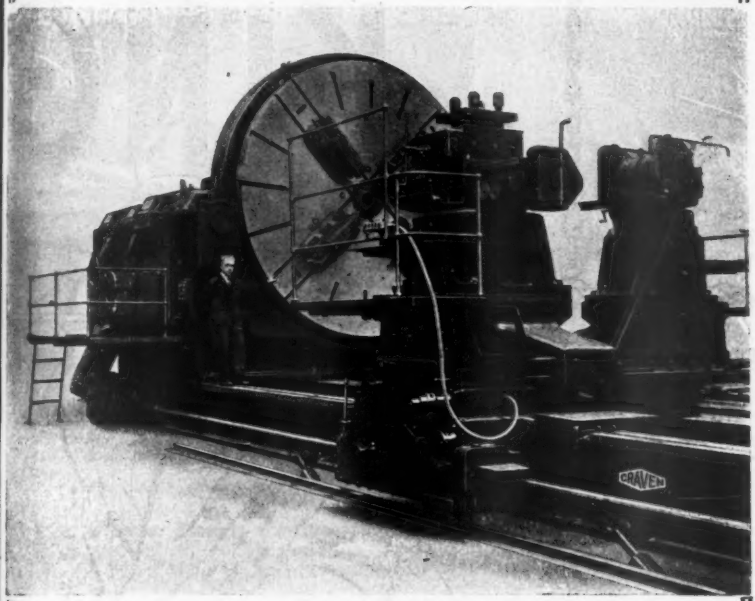

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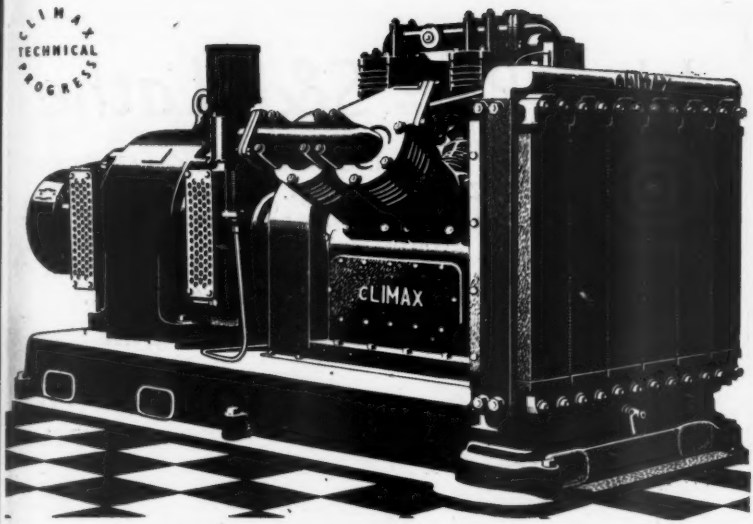

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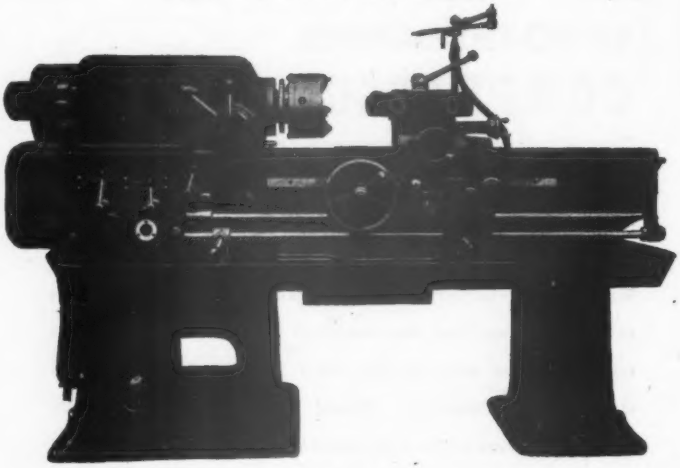

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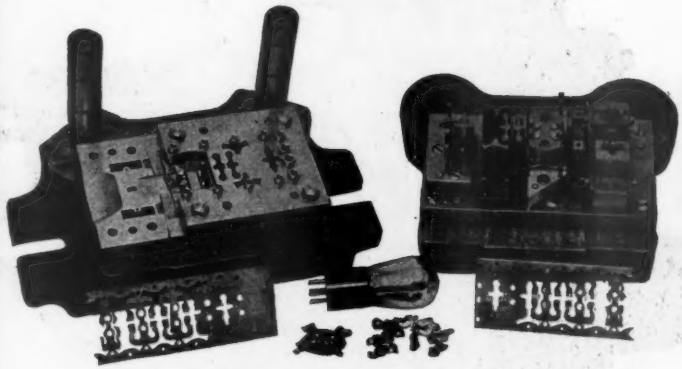

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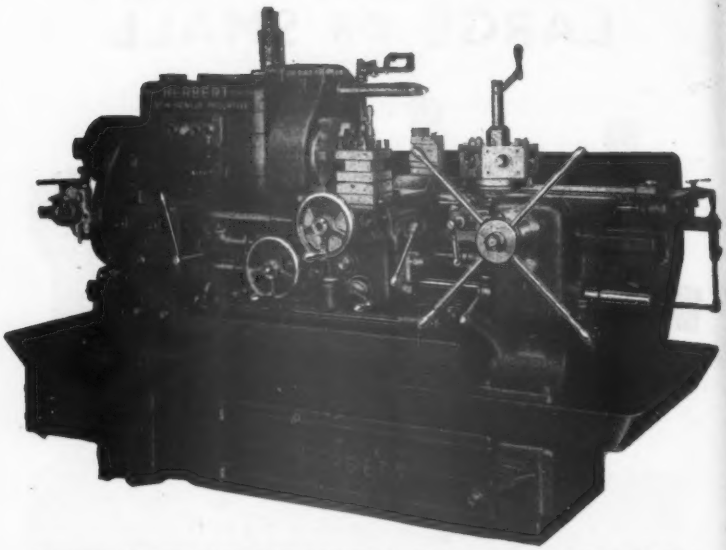

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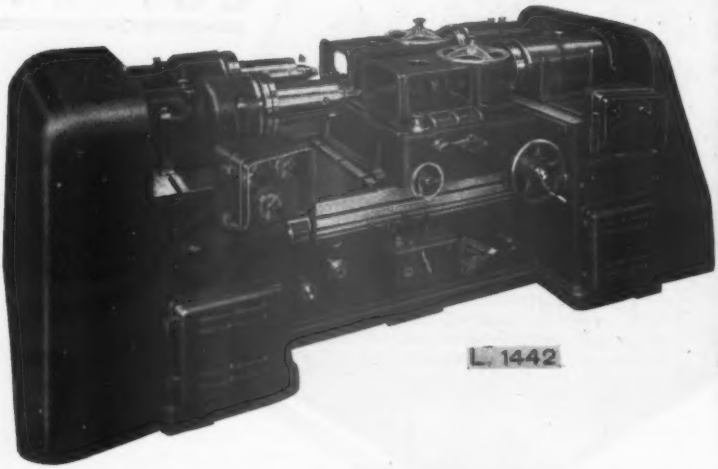

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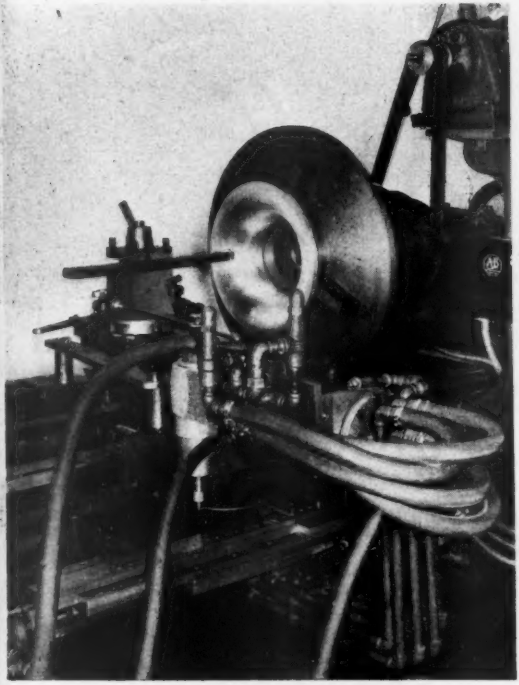

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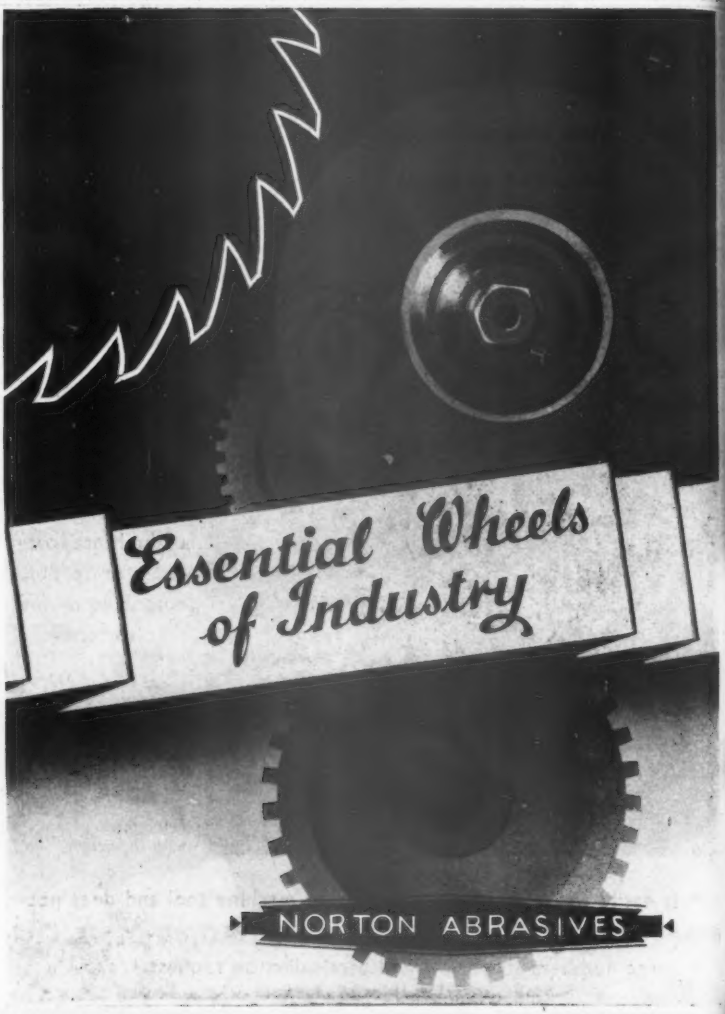

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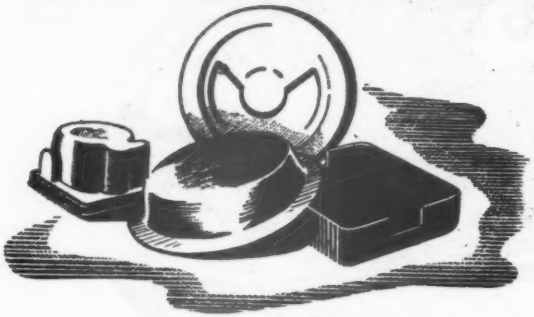

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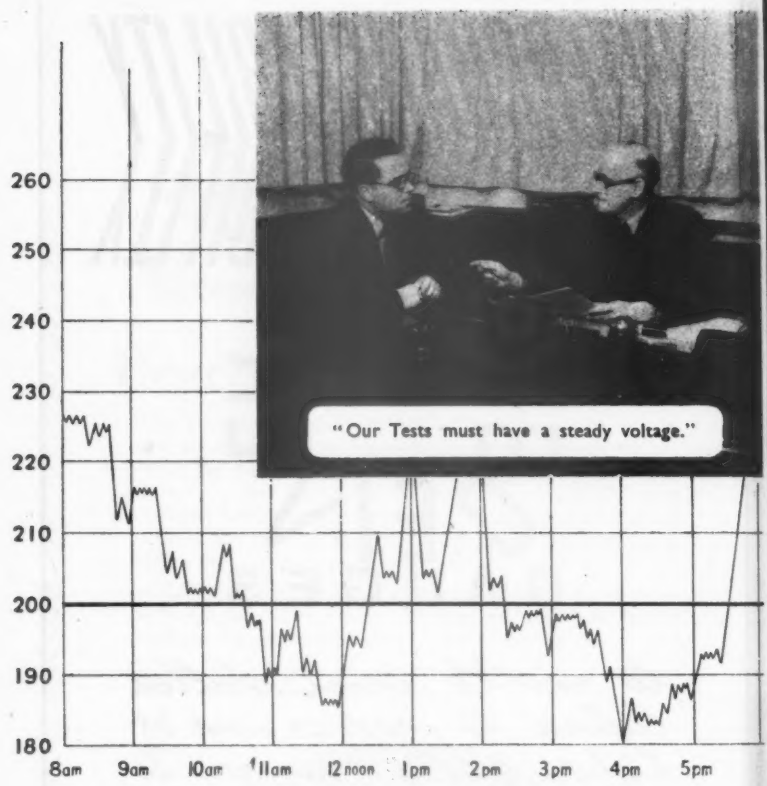

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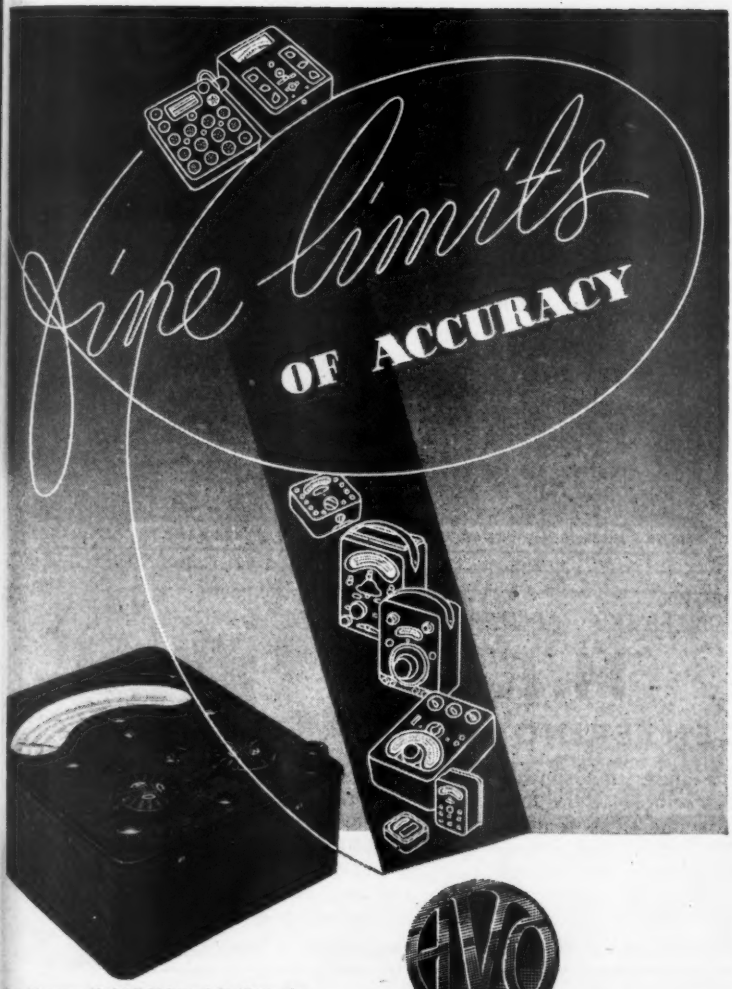

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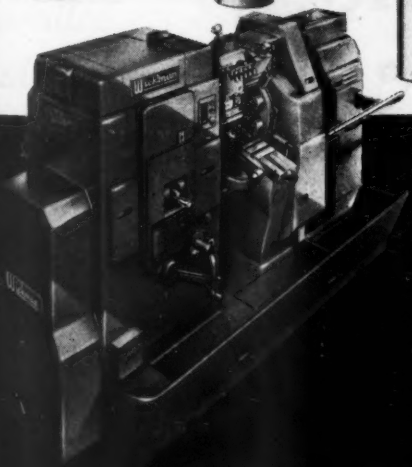

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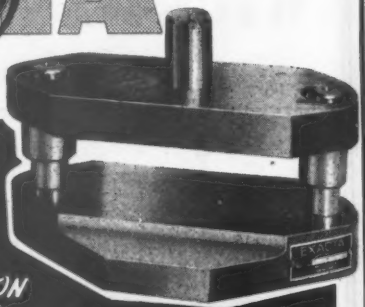

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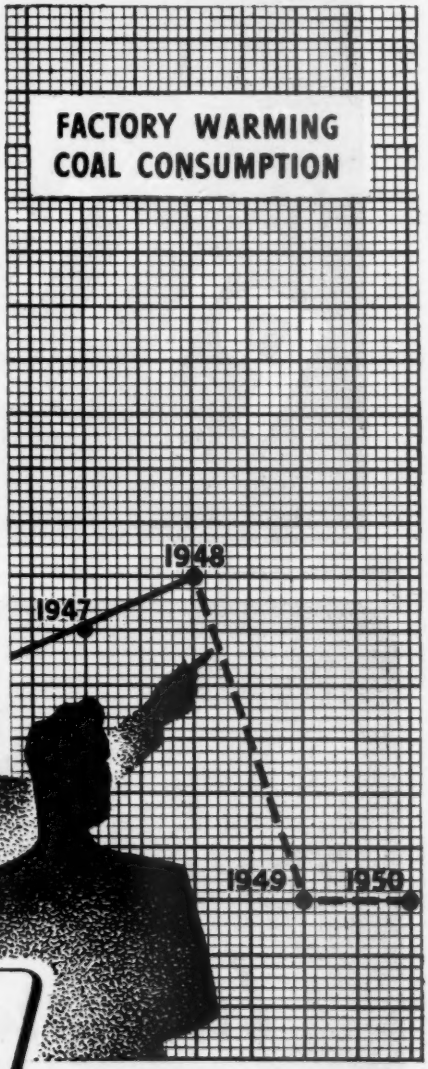

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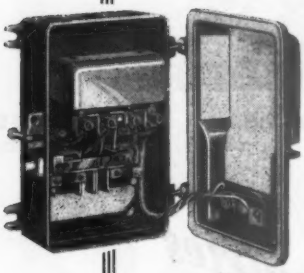

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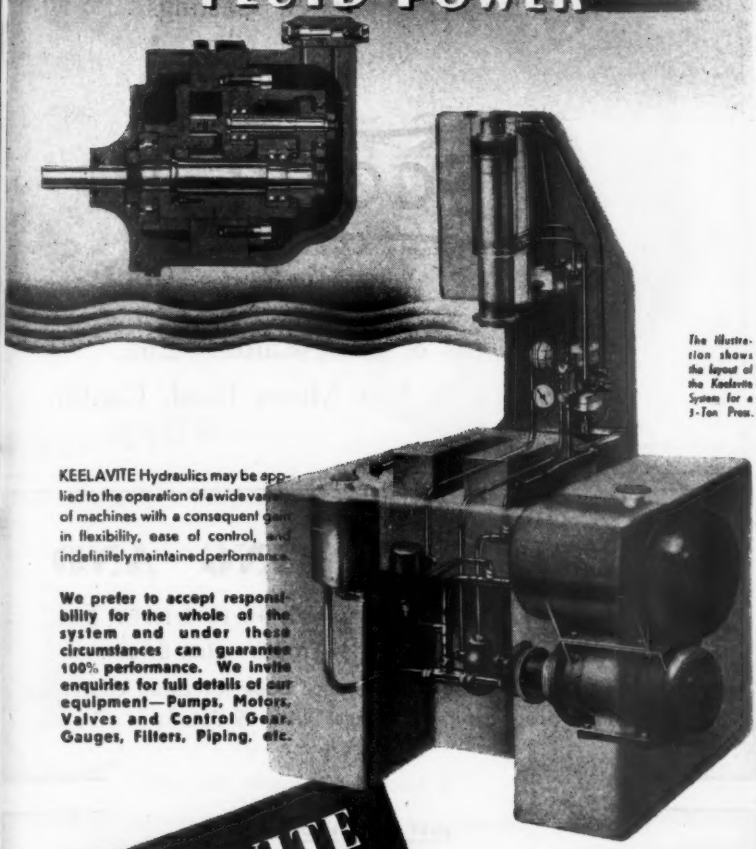

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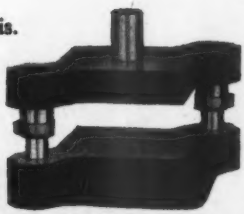

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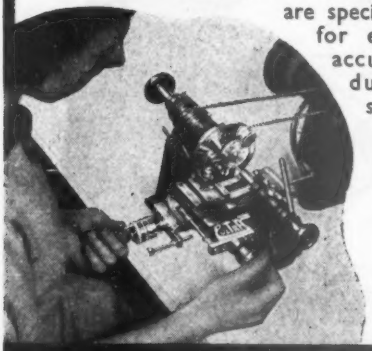

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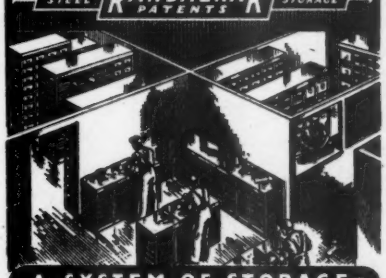

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INDEX TO ADVERTISEMENTS

	Page
Arnott & Harrison, Ltd.	xxxii
Asquith, Wm. Ltd.	xii
Automatic Coil Winder Electrical Equipment Co., Ltd., The	xliv
Barber & Colman, Ltd.	xxiii
Bilton's Abrasives Ltd.	xxvi
Birlec, Ltd.	xi
Bratby & Hinchliffe, Ltd.	xxvii
British Steel Founders Ass.	x
Burton, Griffiths & Co., Ltd.	vi
Carborundum, Ltd.	vii
Catmur Machine Tool Co., Ltd.	xxxvi
Cincinnati Milling Machines, Ltd.	xxv
Climax Rock Drill & Engineering Works, Ltd.	xxx
Coley Bros. (Tools) Ltd.	xlvii
Constable & Co., Ltd.	liii
Coventry Gauge & Tool Co., Ltd.	xiv
Craven Bros. (Manchester) Ltd.	xxviii
Crittall, Richard & Co., Ltd.	xlviii
Dean, Smith & Grace, Ltd.	xxxi
Desoutter Bros., Ltd.	xvii
Desoutter Bros. (Die Sets), Ltd.	liv
Donovan Elec. Co., Ltd.	li
Drummond Asquith (Sales), Ltd.	iii
English Numbering Machines Ltd.	xlv
Firth, Thos. & Brown, John, Ltd.	xxi
Fletcher, Miller, Ltd.	xli
Foster Transformers and Switchgear	xliii
G.P.A. Tools & Gauges, Ltd.	l
Guylee, Frank, & Son, Ltd.	lviii
Herbert, Alfred, Ltd.	xxxiii
Higgs Motors, Ltd.	xxxix
Holman Bros., Ltd.	lvi
Imperial Chemical Industries Ltd.	xviii
Keelavite Rotary Pumps & Motors, Ltd.	lii
King, G. W., Ltd.	xxix
Lloyd, Richard, Ltd.	xxxiv
Lund, John, Ltd.	xxxv
Manchester Repetition Eng., Ltd.	xlv
Mills, James, Ltd.	vii
Mollart Engineering Co., Ltd.	ix
Motor Gear & Engineering Co., Ltd.	lv
Newall, A. P., & Co., Ltd.	xxiv
Norton Grinding Wheel Co., Ltd.	xxxvii
Parkinson, J., & Son	v
Pitter Gauge & Precision Tool Co., Ltd.	xlii
Pryor, Edward, & Son Ltd.	xl
Pulrra Ltd.	lv
Randalrak Ltd.	lvi
Ratcliffe Tool Co., Ltd.	xlvii
Reavell & Co., Ltd.	xix
Sanderson Bros. & Newbould, Ltd.	xlvix
Snow & Co., Ltd.	xvi
Taylor & Jones, Ltd.	xv
Technically Controlled Castings Group, The	liii
Tecnaphot, Ltd.	lvi
Timbrell & Wright Machine Tool & Engineering Co., Ltd.	xx
Towler Bros.	xxii
Unbrako Socket Screw Co., Ltd.	ii
Universal Tool, Ltd.	xlix
Vaughan, Edgar & Co., Ltd.	xxxviii
Ward, H. W., & Co., Ltd.	iv
Wickman, A. C., Ltd.	xliii, xlvi
Wolverhampton Die Casting Co., Ltd.	xl

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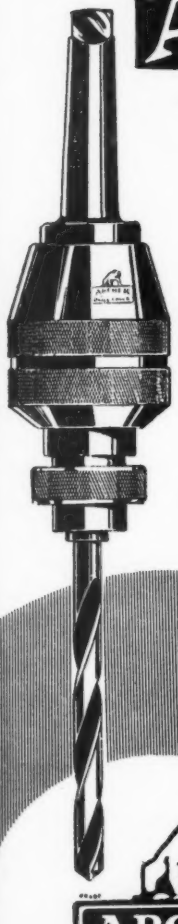

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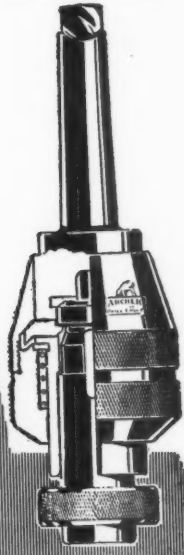

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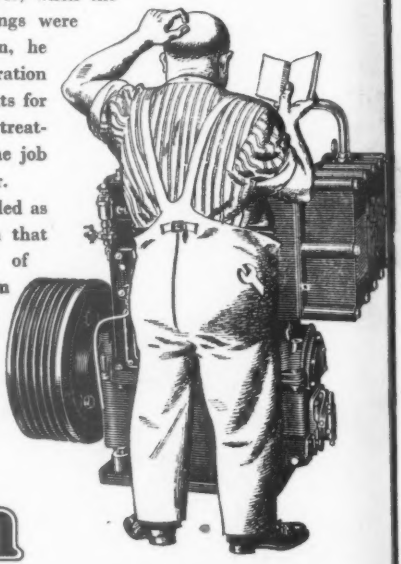

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